POWER

Volume 54 New York, August 2, 1921 *Number* 5

Boiler Statistics and Supervision

THERE are those who still object to governmental supervision of the design, construction and operation of steam boilers as paternal, meddlesome and unnecessary interference with private initiative and enterprise. Their interpretation of "less government in business" is to be "let alone" to build any old kind of a boiler in any old way that they please and run it at any old pressure that they want to, under the charge of the husky who will shovel coal under it for the least money.

How much this policy has cost the industries of America, and through them the American people, will never be known. There are no statistics of the number and ages of the boilers in the United States, of the number added and scrapped each year, nor even of those which explode, except such unofficial and incomplete statistics as are compiled from newspaper clippings and other sources by private concerns.

According to the Hartford Steam Boiler Inspection and Insurance Company, 1920 produced the largest number of boiler accidents of any year yet recorded; 652 against 550 for the largest previous year, which was 1909. The number of personal injuries, serious and fatal, has fallen off, however, being 137 killed, 262 injured, 399 in all for 1920.

It would be interesting if those who have the information in detail would make an analysis of these statistics. What is the most prolific cause of boiler explosions or of major accidents to boilers? What kind of boilers are most affected? How are the accidents distributed geographically? Do the states that have intelligent boiler legislation, intelligently administered, have more or less accidents than other states? Is there any tendency as to time? Former observers have noted a tendency for boilers to explode on Monday or the day following a holiday, when the plant was being started up after a shutdown, or when a boiler was being cut into the line. What proportion of the affected boilers have been inspected by a government or insurance-company inspector?

We hope that this information will be forthcoming and that the day is close at hand when the prevention of these accidents, the cost of which is ultimately borne by the public, will be recognized as a proper governmental function, that each state will have a boiler-inspection department, that the heads of these departments banded into a national organization will be able to so perfect and co-ordinate their work that there will be a live census of the boiler power of the country and an intelligent analysis of all the factors bearing upon it.

F. R. LOW.

Hydro-Electric Practice—Draft Tubes

Various Types of Draft Tubes Discussed and Comparison of Their Efficiencies Made—Draft Tube Efficiency of More Importance in Low-Head Than High-Head Plants

By C. VOETSCH
Hydraulic and Electrical Engineer, Utica Gas and Electric Co., Utica, N. Y.

IN THE ARTICLE, "Hydro-Electric Practice—Features of Design," in the May 24 issue, the present upper limits for the specific speed of Francis turbines obtained was 106 at maximum power or 102.3 after deducting 5 per cent of this power for a safety margin and still have an efficiency of 90 per cent at part gate. Any runner may be overspeeded in order to get a higher specific speed, but only by sacrificing efficiency which, of course, would be poor policy. A new type of runner (Fig. 1) was recently designed having a specific speed of 162, the highest ever obtained. With one design a maximum efficiency of 86 per cent was obtained at part gate and a specific speed of 126 at full gate; with another design an efficiency of 85 per cent was obtained at part gate and a specific speed of 162 at full gate. These are remarkable figures, and a comparison with the Zowski wheel is presented in Fig. 2. It is found that this wheel is not very sensitive to changes in head and, therefore, is economical as a high-water unit in plants with large variations of head due to flood water. Such units generally become large and an increase in speed means cheaper generators, requiring less floor space and a saving in cost.

The efficiency of such a flood unit is not of prime importance, and a loss of five per cent is more than

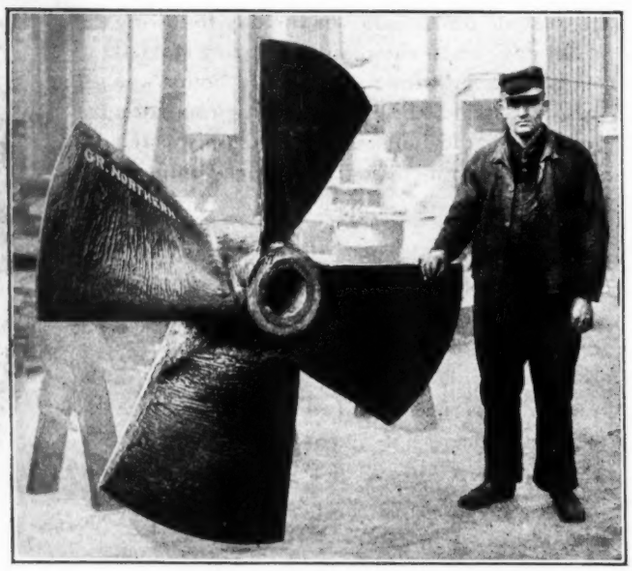


FIG. 1. RUNNER FOR NAGLER-TYPE TURBINE

offset by the gain in the other direction mentioned in the foregoing, as at flood stage water is abundant. There are plants that are practically put out of action at flood stages on account of the reduced head and the inherent low efficiency of the Francis wheel under such conditions, therefore a flood unit as that shown in Fig. 1 may be a good solution of the problem. Using this runner with the latest design of draft tubes, the hydraucone, the efficiency of the entire unit may be raised to that of present-day installation using Francis turbines. The field of application for this new type of runner is particularly for heads under 30 ft., preferably 5 to 20 feet.

The Francis wheel, being of the reaction type, can be set above or below the tailrace-water level. On account of accessibility it is exclusively placed above the tailrace level, although during flood stages the tailrace level may rise above the center line of the turbine

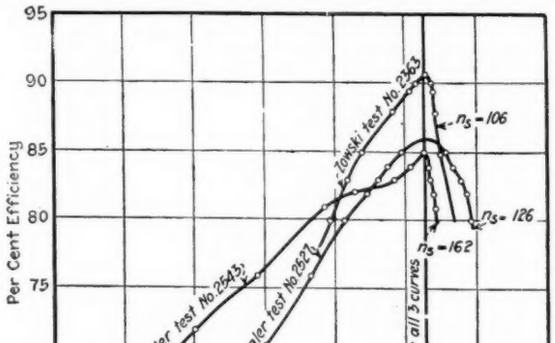


FIG. 2. COMPARISON OF NAGLER AND ZOWSKI RUNNERS

without injury to the efficiency in this respect. The head between runner discharge and tailrace-water level is utilized by the continuation of the band of the runner. This connection was originally a straight cylinder with the disadvantage of losing all the velocity head of the runner discharge. The late Professor Pfarr at Darmstadt deserves the credit of the idea of enlarging the draft tube toward the discharge end, thus regaining some of the discharge velocity from the runner by the negative acceleration of the water which is transformed into draft head.

The draft tube, then, was designed as a straight cone made of steel or cast iron. Later on, for vertical-shaft installations in particular, it formed a 90-deg. bend discharging horizontally and was molded in the concrete foundation of the unit. At first the designers of such curved concrete draft tube considered only a smooth bend, gradually enlarging in order to obtain a gradual reduction of the velocity toward the tailrace. Later on it was demonstrated that the enlargement of the successive cross-sections should conform with a certain law and that there should always be some accelerating head available during the entire course of the flow through the draft tube. In addition to this in some cases the draft tube was curved as an involute. But also this kind of curved draft tube is surpassed, at least for low and medium heads, as it was found that the straight conical elongation of the runner band should be maintained as long as possible.

There has recently been considerable activity among the various turbine designers to obtain more efficient forms of draft tubes, and several patents covering this part of the turbine have been granted. The Wellman

Seaver Morgan Co. has developed a form of draft tube that shows considerable increase in efficiency compared with the older types. The draft tube (see Fig. 3) maintains the conical elongation of the runner band as long as possible, then has a sharp curvature from the vertical to the horizontal direction and a rather sudden sidewise enlargement on the horizontal part, with the floor raised considerably; that is, the horizontal part being rather flat and wide. Tests made at the Holyoke Testing Flume have proved a decided gain in efficiency. Fig 3 shows one of the 55,000-hp. units being installed at Queenston by the Hydro-Electric Power Commission of Ontario, on which this type of draft tube is used.

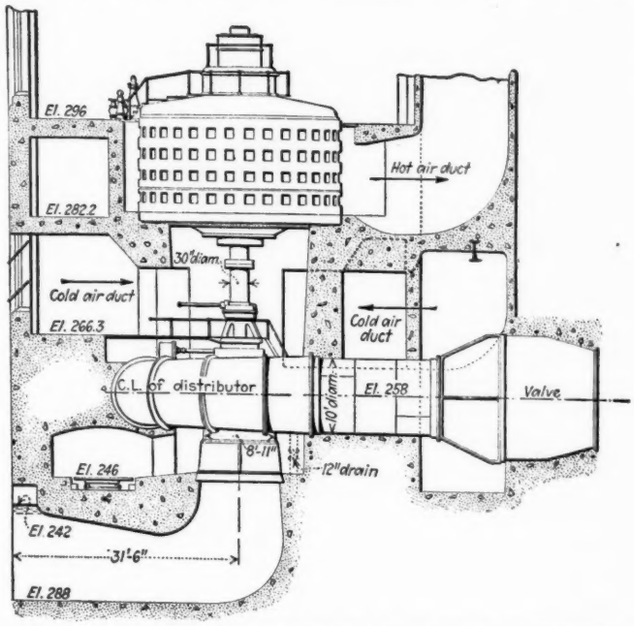


FIG. 3. UNIT FOR HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO, QUEENSTON DEVELOPMENT; 55,000 HP. UNDER 305-FT. HEAD. RUNNER CAN BE REPLACED THROUGH DRAFT TUBE

Another development in draft-tube design is the "Hydraucone Regainer," an invention of W. M. White, manager, hydraulic department of the Allis-Chalmers Manufacturing Co. Its application is shown in Fig. 4, in connection with one of the new 37,500-hp. units for the Niagara Falls Power Co. While the efficiency of the best forms of commercial curved tubes seldom exceeds 25 to 40 per cent of the energy contained in the discharge velocity from the runner, or in faulty constructions even less, it is possible to obtain an efficiency of 70 per cent in this part of the turbine by the application of a hydraucone. The application of the hydraucone to a horizontal-shaft turbine is shown in Fig. 7.

A third type, called the "Spreading Draft Tube," was designed by L. F. Moody, consulting engineer, Wm. Cramp & Sons Ship and Engine Building Co. This type permits a longer extension of the draft tube proper than the hydraucone. Figs. 4 and 5 show a cross-section through the turbines installed at the Niagara Falls Power Co., showing a "Hydraucone" and a "Spreading Draft Tube." A comparison of the efficiencies of the two types at different rates of discharge is shown in Fig. 6. The two curves show no appreciable difference, particularly when considering that the efficiencies refer to the draft tube only and the respective regain of the discharge loss of the turbine, which again is only a percentage of the total head. Evidently there is an advantage in the trumpet-shaped enlargement at the end of the draft tube, and tests with diverging pipes of various forms have proved this. Prof. A. H. Gibson, of University College at Dundee, published his investigations in *Engineering*, London, Feb. 16, 1912, giving a formula for the most efficient cross-section. Professor Prazil, in *Schweizerische Bauzeitung*, 1903, page 207, also in *Die Turbine* III, 1909, page 43, and others have derived

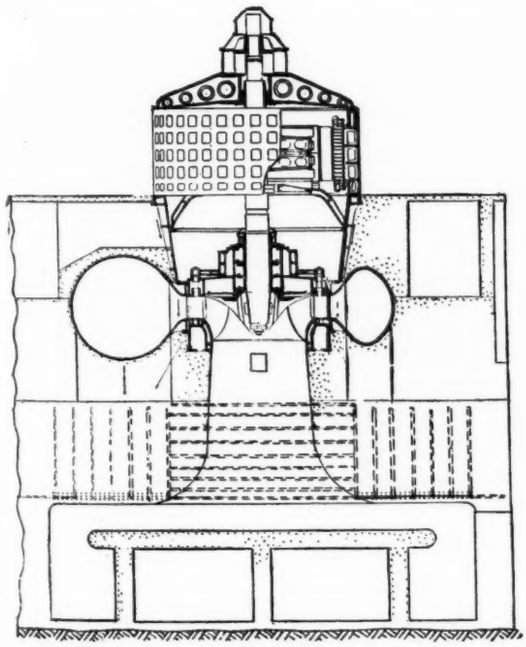


FIG. 4 SECTION THROUGH ONE OF THE 37,500-HP. NIAGARA FALLS POWER CO.S UNITS, SHOWING HYDRAUCONE REGAINER

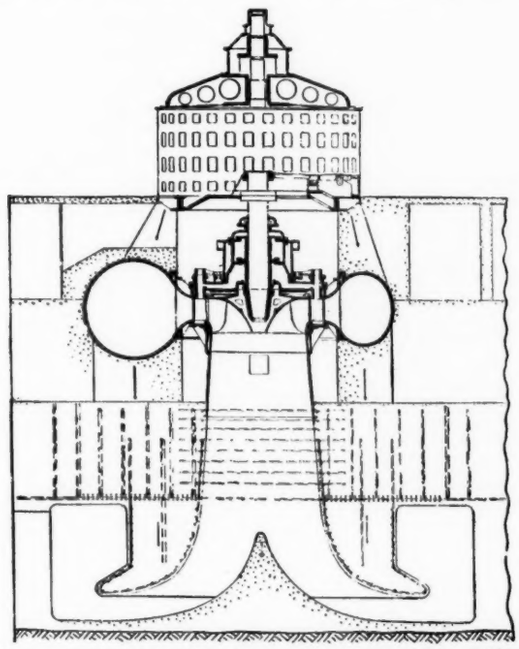


FIG. 5. SECTION THROUGH ONE OF THE 37,500-HP. NIAGARA FALLS POWER CO.'S UNITS, SHOWING SPREADING DRAFT TUBE

formulas and laws with which the draft-tube outlines can be determined.

It is very difficult to make reliable draft-tube tests, and the only way is to compare two machines having the same setting with different draft tubes only. Fig. 8 shows a comparison between a hydraucone and a draft tube kept straight axially as long as possible and provided with a relatively sharp bend to the horizontal. The latter type showed a somewhat better result, as it raised the turbine efficiency close to 2 per cent higher than the hydraucone.[1]

It appears from the foregoing that there are various ways of improving the draft-tube action, particularly in

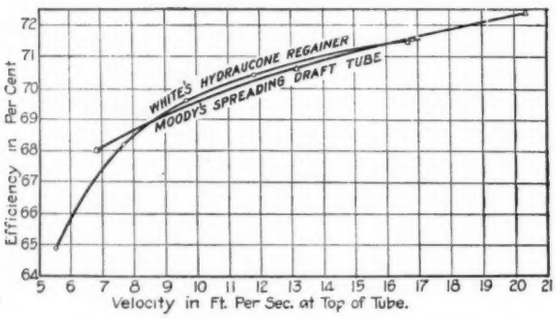


FIG. 6. EFFICIENCY CURVES OF HYDRAUCONE REGAINER AND SPREADING DRAFT TUBE

case of installations with high-speed turbines. How little improvement a high-head plant with a low specific speed turbine will experience may be seen from the following comparison:

Taking, for instance, a turbine runner of a specific speed, $n_s = 30.5$; diameter of the runner at the center line of the case, $D_1 = 30$ in.; net head, $H_n = 310$ ft.; peripheral-speed coefficient at the band, $U_1 = 0.6915$. If Q_n is the quantity of water discharged by the turbine, in this case 88.5 cu.ft.sec. and F the cross-sectional area of the draft tube at a point nearest to the start of the curvature, in this problem 4.58 ft., then the water

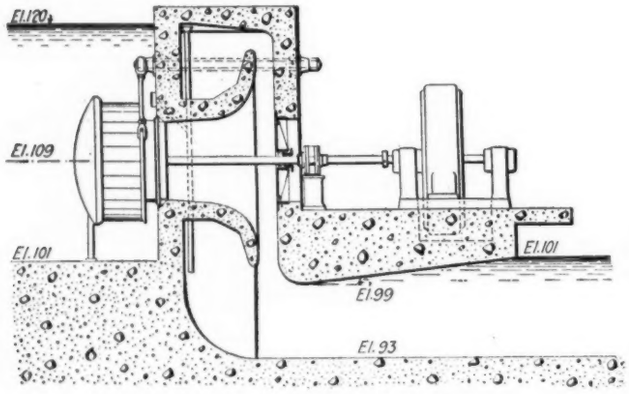


FIG. 7. HYDRAUCONE APPLIED TO HORIZONTAL-SHAFT TURBINE

will leave the runner with an axial velocity component of $V_2 = \frac{Q_n}{F} = \frac{88.5}{4.58} = 19.3$ ft., or a velocity head of $\frac{V_2^2}{2g} = \frac{19.3 \times 19.3}{2 \times 32.16} = 5.79$ ft. Deducting from this the velocity head $\frac{V_3^2}{2g}$ due to the discharge velocity from the draft tube, the friction losses on the concrete surfaces H_r, the eddy losses and other disturbances H_w, which all combined may be taken as 3 ft. velocity head, then the remaining effective draft head will be $H_e = \frac{V_2^2}{2g} - \frac{V_3^2}{2g} - Hr - Hw = 5.79 - 3 = 2.79$ ft. Assume that the old-type draft tube can regain 25 per cent and the new type 75 per cent of this velocity head,

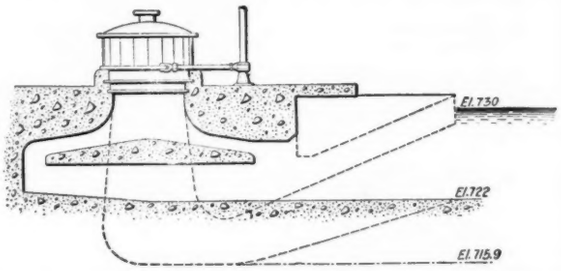


FIG. 8. COMPARISON OF HYDRAUCONE AND CURVED DRAFT-TUBE INSTALLATIONS

The regain will then be, with the old type, $0.25 \times 2.79 = 0.697$ ft. head and with the new type $0.75 \times 2.79 = 2.091$ ft. head. Balance in favor of the new type is 1.394 ft., or $\frac{1.394 \times 100}{310} = 0.45$ per cent, practically $\frac{1}{2}$ of 1 per cent. The same computation applied to a runner of $n_s = 70$, $D_1 = 30$ in., $H_n = 56.5$ ft., $U_1 = 0.77$ will show a regain of 2.37 per cent, practically 2.5 per cent. With a low-head wheel, having $n_s = 102.3$, $D_1 = 30$ in., $H_n = 37.5$ ft., $U_1 = 0.815$ will show a regain of 3.8 per cent, or practically 4 per cent.

While the regain in case of a high-head turbine of low specific speed is relatively small, it is a consider-

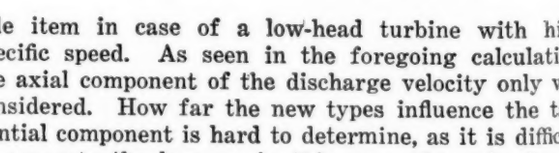


FIG. 9. DIAGRAM OF TANGENTIAL AND AXIAL VELOCITY COMPONENTS IN DRAFT TUBE

able item in case of a low-head turbine with high specific speed. As seen in the foregoing calculation, the axial component of the discharge velocity only was considered. How far the new types influence the tangential component is hard to determine, as it is difficult to separate the loss or, in this case, the gain due to the individual components by actual tests. A probable regain of power from the tangential component can only be very small between full and three-fourths load, but at still smaller loads this tangential component is increasing rapidly and with it the chance for regain, while the axial component is decreasing, resulting in better part-gate efficiencies (see Fig. 9).

A high-head plant with its low specific-speed turbines is usually located high enough above tailrace-water level so that curved draft tubes can be given a considerable straight cone before entering the bend, and therefore better draft-tube action is secured thus reducing the foregoing computed difference in efficiency

[1] *Electrical World*, Dec. 25, 1920.

between the two types to an insignificant value. In a low-head plant with its high specific-speed units the turbine is generally of large size compared with the distance from turbine to tailrace; a short curvature of the draft tube starting near the runner discharge will be necessary in order to keep the excavation within reasonable limits with the result of poor efficiency in regaining the energy still left in the runner-discharge velocity.

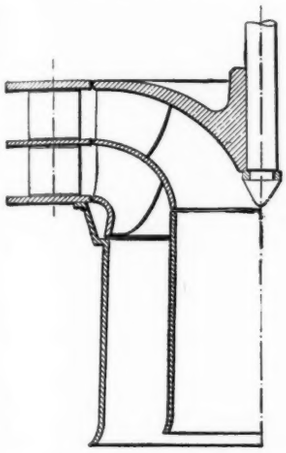


FIG. 1. SECTION THROUGH TURBINE WITH CONCENTRIC DRAFT TUBE

The two types of draft tubes, the hydraucone and the spreading type, have a considerable less overall length, which would mean a reduction in excavation. However, the width at the discharge is materially increased, but the sidewise excavation is considerably cheaper than the downward. It is a different question, however, if the spacing of the units will have to be increased, and consideration must be given to this feature in designing a new power house with many units.

Tests have been conducted in Germany with concentric draft tubes, Fig. 10, more for the purpose of sectionalizing the turbine for better operation and higher efficiencies at part gate. Although the hydraulic radius of the cross-section is increased and with it the friction losses, the whirl is reduced considerably at part gate.

Another important point, which should not be overlooked in new designs or in checking up old plants where trouble in regulation is experienced, is the draft head. The permissible draft head should be in accordance with the formula,

$$\text{Atmospheric pressure } P = H + \frac{V_2^2 - V_3^2}{2g} - F$$

where H is the permissible draft head measured from the center of gravity of the runner discharge area to the tailrace-water level, V_2 the discharge velocity from the runner, V_3 the discharge velocity from the draft tube and F the friction head, eddy and other losses in the draft tube. For safety against a quick-acting governor P should not exceed about 27 ft. for large and about 29 ft. for small wheels instead of the prevailing atmospheric pressure equaling a 33-ft. water column, approximately.

Scroll cases made of steel plate and riveted together in sections are coming into favor, and large plants like the Yadkin River plant, 27,000-hp. units, and one of the Niagara Falls Power Co., 37,000-hp. units, are equipped with this kind of scroll case. (See *Power*, Sept. 14, 1920, for description of Niagara Falls installation.) It may be claimed that the rivet heads will cause a considerably larger loss than is experienced with cast-iron scrolls. But cast-iron and particularly cast-steel scrolls are usually large castings and not always as smooth as might be expected. Furthermore, the length of the water course is rather short, so that a comparatively higher loss, if there is any, will hardly be of importance and is balanced fully by the advantages in saving labor, material and freight, and permits an easy transportation through mountainous districts. It is particularly well adapted where the spiral is embedded in concrete, but is used also for horizontal shaft arrangements

Gas-Engine Troubles

By G. Grow

Not so long ago I was asked to visit a plant where two 1,000-hp. gas engines were furnishing power for central-station service. These engines were of the tandem double-acting type, having single-slipper crossheads, overhung cranks and outboard bearings, as shown in Fig. 1. I was informed by the management that the engines had run beautifully for a number of years. Recently, so I was told, the rear cylinder of one of the engines had been removed and rebored since the heavy service had caused this cylinder to wear about ¼ in. out of round. After the cylinder had been replaced and the engine reassembled, for some unknown reason the engine pounded and the front cylinder had started to wear very rapidly. The plant force could not solve the mystery, and it was up to me to play the doctor.

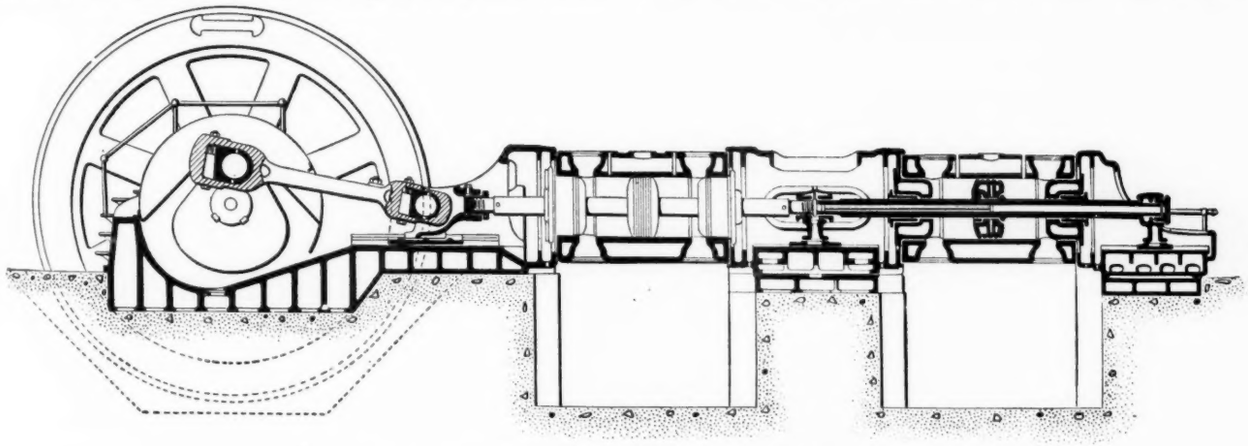


FIG. 1. CROSS-SECTION OF TANDEM GAS ENGINE

The watch engineer started the engine for me, and I must confess that I felt like moving myself out of

the plant. The place sounded more like a boiler plant than an engine room. The pound apparently was in the crankpin bearing, although there was so much clearance in the main bearing that by placing a lead pencil through the oil hole in the cap the shaft could be felt to give at each stroke. I also noticed that the crosshead apparently lifted and tilted to one side on the crank stroke, but was told that if the shoe was made to fit more snugly the entire crosshead got hot. Wandering toward the cylinder end of the engine, I noted that the tail-rod crosshead was also quite loose and running pretty warm. The more I saw of the machine the more I felt that I was up against a stiff job of overhauling.

We shut the engine down, and I had the men bar the flywheel around, while I measured the clearance between the connecting rod and cheek of the crank at front and rear centers. I found that the clearance when on the forward dead center was over $\frac{1}{8}$ in. greater than when on the rear dead center. This seemed to indicate that the piston rod and mainshaft were out of alignment. The engineers insisted that the engine had been checked for alignment when the cylinders were replaced. On the other hand, the unequal clearances proved that the connecting rod at least was not square with the shaft, and in view of the side movement of the crosshead, I was certain the piston rod was out. Since it was necessary to remove the pistons and rods to check the alignment of rod and shaft, we started to work and after uncoupling the rods from the center crosshead, withdrew part of the rod and the front piston through the front cylinder. The rear piston and rod were pulled out through the main frame. A fine piano wire was then stretched through the cylinders and passed through slotted tin plates which were fastened to blocking at each end of the engine foundation, as in Fig. 2. The two cylinders were calipered and an endeavor made to center the wire. It was found that the head cylinder was low at the front end. The engineers claimed that they had tightened all the frame bolts and could not understand, if the bolts were all snug, how the cylinder could drop out of alignment. The fact was that the foundation at the front end was

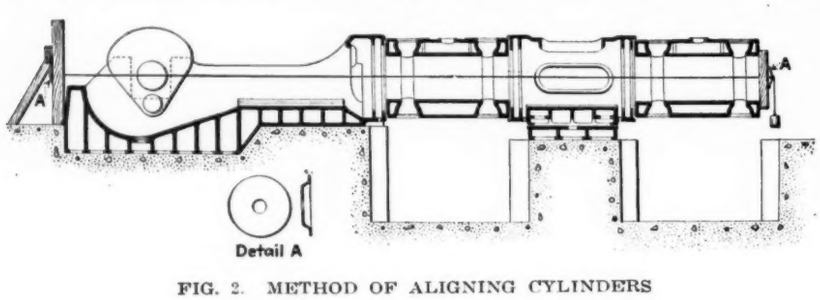


FIG. 2. METHOD OF ALIGNING CYLINDERS

low, and on replacing the cylinder no attempt was made to remedy the fault. Finally, by shimming up the front cylinder base, we were able to get the center line to check for each end of the two cylinders. We were a bit doubtful as to the accuracy of the piano-wire line since, due to the length of the line, there was a possibility of the wire bowing in the center. Many engineers attempt to check this by placing a spirit level against the wire. There is room for error since it is practically impossible to hold the level to allow it to barely touch the wire along the level's length. To avoid this, we drew the piano wire very taut and then placed blocking under the wire upon which to rest the level, which was raised by shims until it just touched the piano wire along the length of the level and we could note the position of the bubble. The level was reversed in order to check the first reading. We found the whole engine slightly out of level. While no serious trouble would have occurred even though a marked departure from the horizontal existed, as long as the cylinders were in alignment, it was thought best to leave no

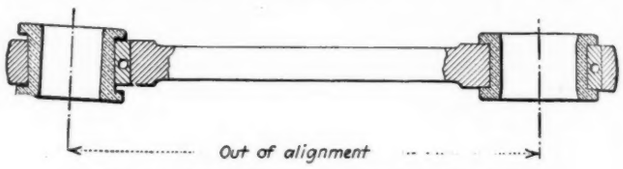


FIG. 3. DEFECTIVE WRISTPIN BEARING

loophole for error, consequently we realigned the entire frame and cylinder assembly.

When it came to checking the position of the engine shaft with regard to the cylinder center lines, we found they were square with each other. This was surprising, as I was sure that the connecting rod had apparently been out of alignment at least $\frac{1}{8}$ in. The engine parts were now reassembled, for it was felt that the settling of the one cylinder was the cause of the cylinder wearing so rapidly. The stiff piston rod had thrown the piston against the upper part of the cylinder, cutting the walls very rapidly. The crosshead slippers were given a nice fit in the guides and were found to take the rods very easily. It was not deemed advisable to attempt to rebore the worn cylinder as the metal was not very thick, the wear was not excessive and we all thought that the piston rings would hold the compression for a good time to come.

After everything was hooked up, the engine was started, and while the main crosshead shoe ran warm and no groaning came from the cylinders, the crankpin bearing pounded as hard as before if not harder. This was a puzzler, for I was positive that our checking of the mainshaft and cylinder center lines was accurate—it followed that the two could not possibly be out of alignment. Stopping the engine, we turned the flywheel over and measured the clearance between the crank web and crankpin bearing. To our surprise the crank was out of square with the box. Not wishing to pull the piston rods again, more out of curiosity than anything else I had the men remove the connecting rod.

The crankpin bearing appeared to be "belled," and calipering the bearing at each end and center confirmed this. The logical deduction was that for some reason the connecting rod did not rotate in the vertical plane through the piston-rod center line, and this in-and-out motion enlarged the bearing ends. On turning to the wristpin bearing, we found it in good shape, but discovered that the bearing bore and bearing face were not at right angles to each other, being like Fig. 3. For some reason, in refitting this bearing the engineer had filed the side when it rested against the adjusting wedge. This tended to throw the rod to one side, and as a result the crankpin bearing pounded; the side strain on the crosshead caused the shoe to run hot unless very loose.

Motor-Control Equipment—Protective Features*

Controllers With Air- and Oil-Break Contactors—Overload Protection—Fuses and Circuit Breakers—Low-Voltage Protection—Protection Against Reverse-Phase Operation

By H. D. JAMES
Manager, Control Engineering Department, Westinghouse Electric and Mfg. Co.

STANDARD controllers are arranged for rupturing the arc either in air or in oil. Each arrangement has its advantages and disadvantages. When an arc is ruptured, the energy of the circuit is discharged through the arc and disappears in the form of heat. When the arc is broken under oil, this heat is absorbed by the oil and must be radiated from the oil tank. Contactors used for frequent service will generate considerable heat in this way. The number of operations and the load determine the temperature of the oil and the size of tank required. It is better to use air-break contactors, Fig. 1, where frequent opening of the circuit is necessary.

The contactor, Fig. 1, has a continuous rating of 500 amperes and is capable of handling an induction motor on a 6,600-volt circuit. Note the size of the arc box and the location of the arc splitters. The stationary contacts are carried on porcelain pillars. The movable contact is connected to the operating magnet by means of a micarta tube. The armature of the magnet is flexibly mounted to allow it to seat readily.

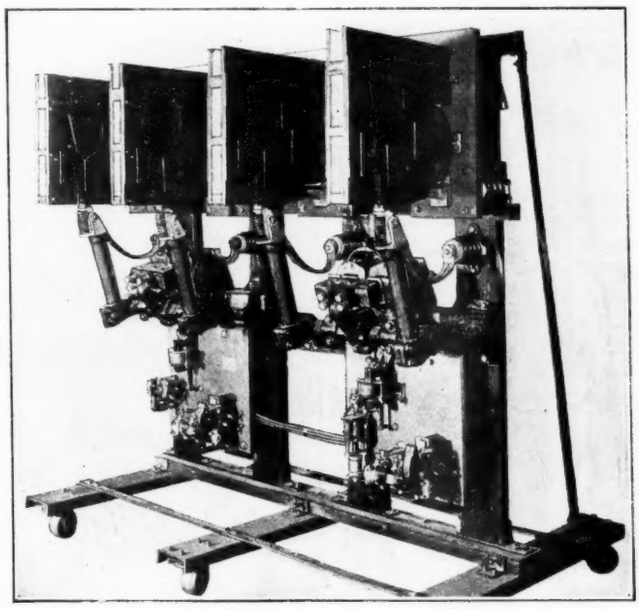


FIG. 1. TWO-POLE 6,000-VOLT MAGNETIC CONTACTOR WITH BLOWOUT

Some applications require rupturing of the arc in the presence of inflammable or explosive gases. In such cases the rupturing of the circuit under oil provides an easy means for preventing the arc from communicating with these gases. For that reason, oil-immersed controllers and contactors are sometimes used in powder mills and gaseous mines.

The oil-immersed contactor, Fig. 2, is more common on 2,200- and 6,600-volt circuits because of the advantages of this construction from an insulation viewpoint. As an example, the creepage distance across an insulated surface for 2,200 volts is approximately 1 in. under oil, and 2½ in. in air. These figures depend on the nature of the surface and the construction of the apparatus, but are given so that a relative idea may be obtained of the insulation problem. The separation of contacts in oil for this voltage is much less than that required in air.

The controller panel, Fig. 2, is for a wound-secondary induction motor having three-point acceleration. The oil-immersed contactor is mounted at the top of the panel. The rear view resembles an oil circuit breaker which is operated by a magnet mounted at the top on the front of the board, similar to the two secondary contactors below. The contacts in the oil tank are duplicates of those shown on the front of the board and have interchangeable arcing tips. The rolling type of contact is used. The secondary of this motor is wound for a low voltage and, therefore, standard air break contactors and resistors can be used. An interesting feature in the panel, Fig. 3, is the use of a series of cam contactors operated by a pilot motor through suitable worm gearing. The pilot motor is located on the rear of the panel and drives a camshaft which closes the contactors in the proper sequence. Controllers of this type give a positive and smooth acceleration, particularly where a slow, gradual start is desired.

Where the arc is ruptured in the air, it is necessary to draw it out to a considerable length. This requires a large arc box, Fig. 1, even when arc splitters are used, so that the oil-immersed contactor is more compact. On the other hand, when the circuit is ruptured under oil, a certain amount of oil is carbonized and settles at the bottom of the tank. The more depth of oil allowed under the contacts the less often will the oil require renewal.

When a voltage exists between electric terminals there is a tendency for particles of matter to be deposited between these terminals along the surface of the insulation. This is quite noticeable on a terminal board for 2,200 volts in the presence of considerable dust. The same tendency exists under oil and results in a deposit of carbon between the terminals. The writer has seen a number of terminal boards showing this effect in quite a striking manner. It is, therefore, advisable to keep the oil fairly clean unless there is a considerable separation of the terminals.

A controller that is used frequently requires attention to the contacts. When the arc is ruptured in the air, these contacts can be readily inspected. If immersed in oil, experience has shown that they receive little or no attention until trouble develops. This is another reason for using air-brake apparatus for frequent service.

Control apparatus is usually protected against overload by either fuses or relays. The standard code fuse is well known and needs no description here. The relay

*All rights reserved.

may open an electric circuit to a contactor coil or low-voltage coil, causing the contact device to open and disconnect the motor; or the relay may act on a mechanical trip, as is usually done with circuit breakers, and in this way mechanically open the line switch.

Fuses have two principal objections: (1) The fuse is destroyed and requires renewal after each overload. In order to render the renewal of the fuses safe for an inexperienced person, a mechanical interlock should be provided to render the fuse inaccessible until the power circuit has been disconnected. There are several types of safety switches on the market which afford this protection in varying degrees. (2) Fuses have a relatively short time element; this may result in overfusing the motor to such an extent that little real protection is afforded against overheating, the fuse merely affording protection against short-circuits and grounds. Manufacturers usually recommend relays for motors that are larger than 10 hp. The fuses required for small motors cost much less than the relay, and the renewal is not expensive.

Relays used for the protection of motors are usually provided with a time element which will permit the motor to carry short-time overloads without being automatically disconnected from the line. This time element is of particular advantage where a small controller is connected to a large feeder. Such an arrangement imposes a very heavy arc-rupturing duty on the controller if the relay operates before the feeder protection on a short-circuit. The time element of the relay should permit the fuses or circuit breaker protecting that particular feeder to rupture the short-circuit. The real function of a relay furnished as part of a controller is to afford protection to the motor against overheating. The time element prevents opening on short-time overloads, so the relay can be set close enough to protect the motor against prolonged operation at dangerous loads.

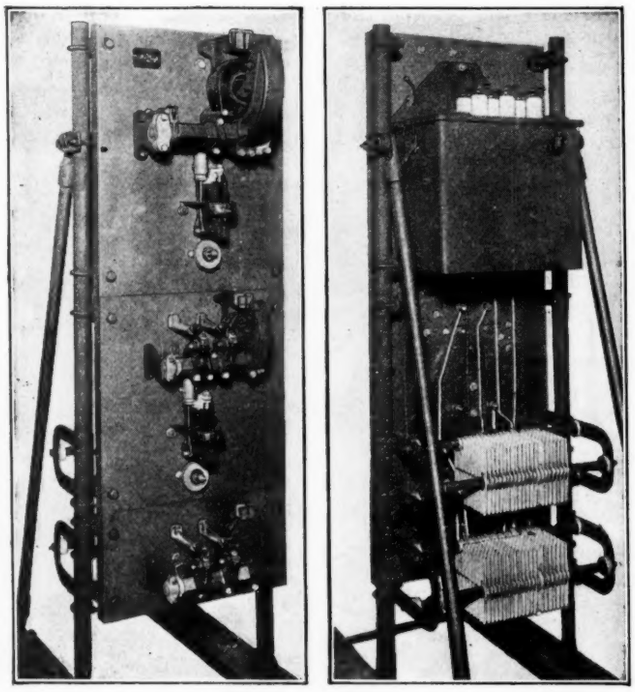


FIG. 2. FRONT AND REAR VIEW OF OIL-IMMERSED MAGNETIC CONTROLLER PANEL

The time-element features of a relay may consist of a dashpot, a geared device or a thermal element. In order to prevent the relay exerting too strong a pull on short-circuits and thereby acting almost instantaneously, a saturated iron circuit can be used to limit this pull. A convenient arrangement for alternating current is a saturated series transformer, the relay being operated from the secondary of this transformer. The transformer core becomes saturated at about 200 to 300 per cent overload.

Dashpots may be of the oil, air or diaphragm type. The most common form is the oil dashpot, Fig. 4. At the center of the panel is shown a two-coil overload relay provided with oil dashpots to give a time element. The knife switch at the right disconnects the main circuits, while the one at the left is in the pilot circuit and is provided with fuses for protecting this circuit. Oil can be used in the dashpot which has a small temperature coefficient and sufficient viscosity to permit a reasonable clearance between the piston and the side of the cup. This gives a relay with a long time element even at the higher temperatures and also one that will function below the freezing point.

Air dashpots are usually of the suction type. They are not very successful for overload relays because the inverse time element, due to an increased pull on the relay plunger, renders their operation too quick on heavy overloads. They also require a close fit between the stationary and the moving element of the dashpot. The diaphragm-type dashpot eliminates this tendency to stick, as there is no movement between a stationary dashpot cup and the piston or plunger; the time element is obtained by forcing the air out of a bellows-like structure through a small opening. One of the difficulties experienced with this type of relay is the drying up and cracking of the bellows or diaphragm. This objection is not serious because any relay will require attention from time to time, and if the diaphragm relay is properly designed, the diaphragm element can be quickly and cheaply renewed. Geared relays have proved very satisfactory for many applications. The principal objection to such a relay is the feeling that gears are unreliable. This, again, is justified only where the gear is poorly designed and not protected from dirt. The time element may consist of a fan acting as a retarding force, or a disk of conducting metal may be revolved between the poles of a magnet similar to wattmeter construction. The usual form of thermal relay consists of a bi-metal strip which is heated by the passage of current either through the strip or through a heater adjusted to the strip. If the current is in excess of normal, it will heat the bi-metal strip so as to make it deflect and open a contact. The length of time required to heat the strip sufficiently to open the contact can be adjusted by the design of the relay.

Protection Against Single-Phase Operation

Polyphase induction motors are sometimes burned out if the power supply is disconnected from one phase. This is usually caused by a fuse blowing in one phase and leaving the other phases connected to the line. If the motor is at rest and fails to start, the overload protective device on the starting connection may be set too high to be opened; in other cases the motor may be operating when it loses one phase. Full load on the motor should increase the current in the other two

phases sufficiently to operate the overload on the running connection before the motor is injured. When there is not sufficient time element in the relay to prevent operation on short-time overloads, the relay may be set too high to open on single-phase operation. The most satisfactory solution of this problem is a long time-element overload relay.

The overload relay is usually set from 125 to 200 per cent of the normal current rating of the motor, depending on the nature of the motor load. Where the load is very constant, the relay may be set as low as 110 per cent of the normal motor load. A value as high as 200 per cent is used for cranes and hoists where the motor operates on a very intermittent cycle.

Low-Voltage Protection

Sometimes the electric power is interrupted by an accident or other causes. If this interruption lasts for more than a few seconds at a time, the motors come to rest. Unless provision is made for disconnecting these motors from the line, they will start again as soon as the power supply is restored. This unexpected starting may cause an accident in many applications.

In order to guard against injury to the motor or unexpected starting when power is restored, a low-voltage attachment is provided on most control equipment. This

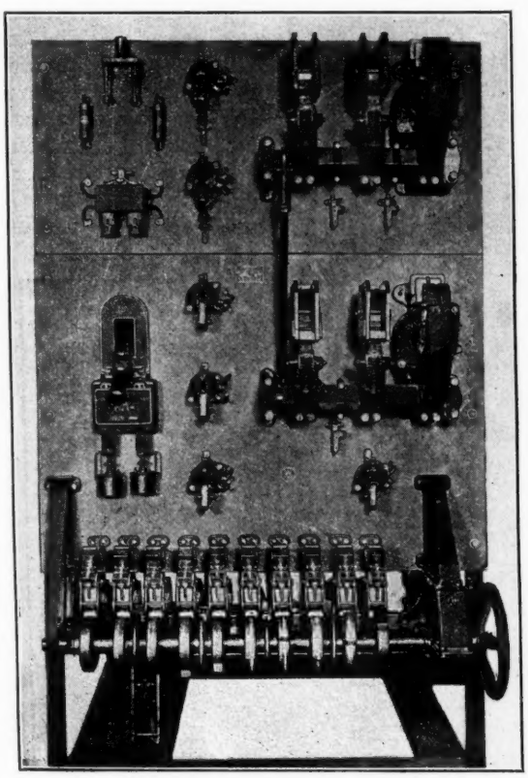


FIG. 3. REVERSING CONTROLLER FOR WOUND-ROTOR INDUCTION MOTOR WITH MOTOR-OPERATED SECONDARY CONTACTORS

protection takes two forms: (a) Low-voltage release and (b) low-voltage protection.

Low-voltage release does not provide protection against the restarting of the motor, but does provide automatic means for inserting the resistance in the motor circuit so that the acceleration is accomplished in the normal manner. An illustration of this would be an ordinary push-button control connected to a pump motor. An application of this kind will usually not introduce an accident hazard if the motor is restarted on restoration of power, and in many cases it is very desirable to restart the motor automatically.

Low-voltage protection, on the other hand, provides positive means to prevent the restarting of the motor on restoration of power. An application of this kind would be a wood-working machine such as a saw. If a push-button controller were furnished, it would be so connected that on failure of voltage all the contactors would open and remain open until the start button was depressed. If a manual controller were used, it might be provided with a spring for returning the handle to the "off" position when the holding magnet was de-energized, or it might be provided with a protective panel consisting of a line contactor which would open on failure of voltage and could not be closed until the manual controller was brought to the central, or "off," position. Sometimes polyphase alternating-current systems have one phase of the circuit reversed, usually due to wrong connections being made during repair work. For instance, if the transformer feeding a building or group of buildings should be changed, it might be reconnected so that the wires feeding one phase were interchanged. A connection of this kind will cause the polyphase motors on the system to revolve opposite to the normal direction, and in some particular applications introduce an accident hazard.

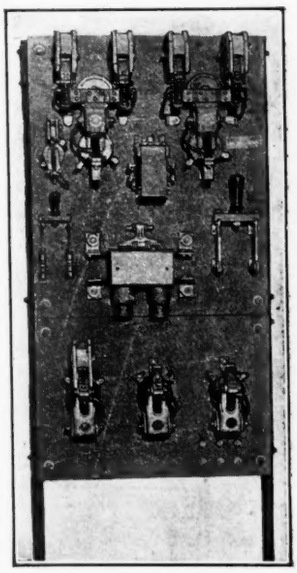


FIG. 4. REVERSING CONTROL PANEL FOR DIRECT CURRENT MOTOR

The hazard can be avoided by means of a reverse-phase relay so connected in the circuit that, when the phase rotation is reversed, the relay disconnects the power circuit from the control apparatus or from an entire building, depending on the connections.

It is desirable to have relays of this type installed in connection with electric elevators operated by polyphase induction motors, and there may be a few other applications where such a relay is necessary. The different commercial relays ordinarily employed for this purpose usually afford low-voltage protection and also phase-failure protection.

If the motor is at rest, these relays will always provide phase-failure protection. If, however, one phase of the supply circuit should become disconnected during operation, the revolving secondary of the induction motor will generate a voltage across the inactive phase which will tend to hold some types of these relays in an operative position as long as the motor continues to run at full speed. When the motor is operated on an intermittent-duty cycle, it will not be injured by continuing to run single-phase until the end of the cycle, when the relay will operate to disconnect the motor. This is the case with elevators, cranes, hoists and similar apparatus. Where the motor operates continuously, the load does not fluctuate over wide limits, and therefore the overload relay can be set close enough to afford protection against phase failure, as previously stated.

Reducing Coal Consumption from 51 to 27 Tons a Day

By H. A. WARD

OUR steam-generating plant, operating 24 hours a day throughout the year, consisted of two 6,500-sq.ft. B. & W. boilers in one boiler house with two 4,500-sq.ft. water-tube and four 1,500-sq.ft. return-tubular boilers located in another, all feeding into a common line. This made a total of 28,000 sq.ft. of evaporating surface, about 20,000 sq.ft. of which was

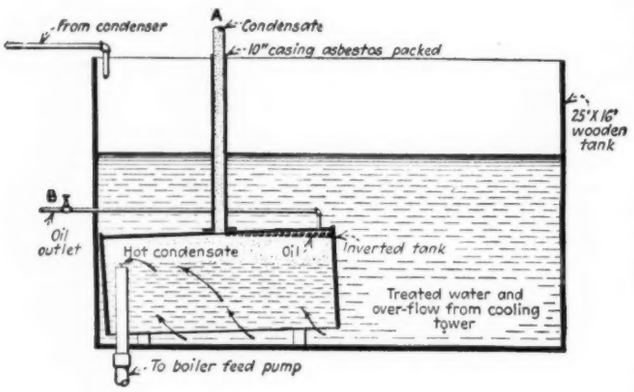


FIG. 1. COMBINATION FEED-WATER TANK

usually in service. All excepting two 1,500-sq.ft. boilers were equipped with Jones underfeed stokers. The pressures carried were from 100 to 125 pounds.

Considerable condensation was returned for feed water, and the makeup water, coming from a deep well, was quite hard. To care for this, we had a lime and soda-ash treating plant. Although all exhaust steam passed through oil separators, the condensation from certain sections of the plant, if returned directly to the boilers, gave trouble from oil. To correct this, the troublesome part of the condensation was mixed with the raw water and put through the treating plant. The proportions of condensation and raw water in the mixture were always unknown, therefore the treatment was seldom right and the boilers rapidly accumulated a hard scale, difficult to remove. The hand lance did not prove effective in removing the soot from the outside of the tubes, so one of the first problems was to get clean heating surfaces.

Oil Remover Is Installed

The feed water was stored in a 50,000-gal. tank 25 ft. in diameter. To eliminate the oil from the condensation and at the same time automatically return the hot water to the feed pump, an inverted wooden tank was installed inside the makeup tank, as shown in Fig. 1. The hot water of condensation introduced through the pipe *A*, at a low velocity, at the top of the inverted tank, remained as a layer over the cooler water, while the oil that entered with it rose to the top and was drawn off through valve *B*. The intake of the feed pump, located 15 in. below the top of the inverted tank, drew from the layer of hot water as it extended down to the intake level and made up the rest from the underlying cold-water layer. This arrangement proved efficient as an oil remover, also in returning the hot water to the feed pump. The temperature of the water as delivered to the pump ranged between 140 and 150 deg. F. From the pump it passed through a closed heater which delivered it at around 212 deg. F.

Supplied with well water only, the treating plant proved very effective. Boilers in service for eight months continucusly showed but slight scale, and the heavy scale in the headers gradually loosened and came down. Modern soot blowers were installed in the two 6,500-sq.ft. and one 4,500-sq.ft. boiler and we soon had clean heating surfaces on those in constant use.

Saving the Condensate

Another problem was the saving of such condensate as was still going to the sewer. All direct connections between returns and the sewer system were broken so that any hot water wasting thereto would be detected. The returns were arranged to bring back all water of condensation with the least exposed pipe surface.

Water for the barometric condensers at the turbine plant was cooled in a fan cooling tower. In order to save the overflow, which was comparatively warm, we took a connection from the discharge of the circulating pump through a float valve controlled by the water level in the bottom of the cooling tower, as shown in Fig. 2.

The prime movers consisted of one 350-hp. Corliss engine belted to a lineshaft and to a 440-volt three-phase

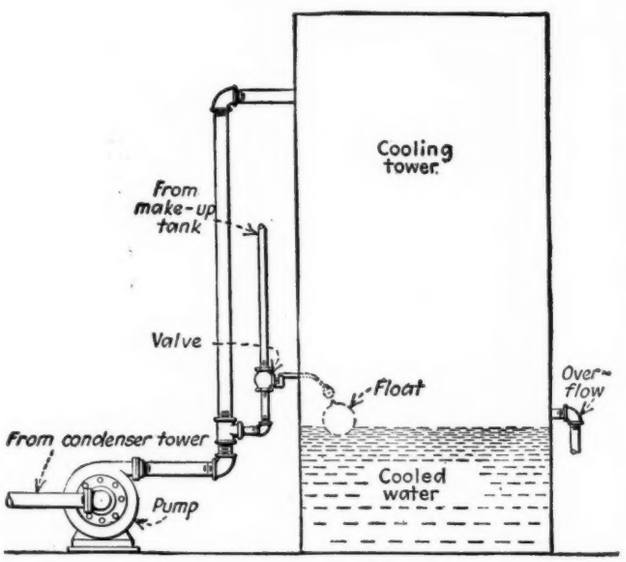


FIG. 2. ARRANGEMENT OF COOLING TOWER

60-cycle generator, and two 300-hp. De Laval condensing turbines, each geared to two 440-volt three-phase 60-cycle generators. All three were operated during the day and all were underloaded. Besides the main units there was a 150-hp. cross-compound engine driving a lineshaft in one building and a double reversible engine driving a shaft in another building. One of the first changes made was the shutting down of one of the tur-

bines. The cross-compound engine was later superseded by a 60-hp. motor obtained by shifting motors in the plant. The double engine was dispensed with by adding its load to that of a neighboring underloaded motor. This cut the number of engines in operation from five to two, at the same time leaving a reserve unit. The Corliss engine was not fully loaded by the generator and lineshaft, and as there were some motor-driven machines within easy reach of the lineshaft, their load was transferred to it.

We also had two steam-driven air compressors for pumping wells, and various steam pumps and steam auxiliaries. All steam-driven machinery, the De Laval turbines excepted, exhausted into a common low-pressure system against a 5-lb. back pressure.

Some 8,000 sq.ft. of pipe-coil radiation located in adjoining buildings was transferred from the high-pressure steam to the exhaust-steam system. Each pipe coil or group of pipe coils was trapped to a liberally proportioned return system vented to the atmosphere. The circulation thus obtained was such that the 5-lb. pressure proved satisfactory on the radiation installed for 100-lb. pressure.

Steam for Vacuum Pans and Drying Rooms

We operated vacuum pans and many drying rooms requiring steam throughout the year. After all radiation and apparatus that could be satisfactorily operated on 5-lb. pressure had been added to the exhaust steam system, we had to supplement the exhaust with live steam through a reducing valve whenever the outside temperature was below 55 deg. F. and at all light-load periods.

High-pressure steam was supplied to 69 ovens in one building and 96 ovens in another. The 69-oven building was old and the steam piping was in poor condition. Both buildings were in use, although for considerable periods there was not sufficient work to fill the larger

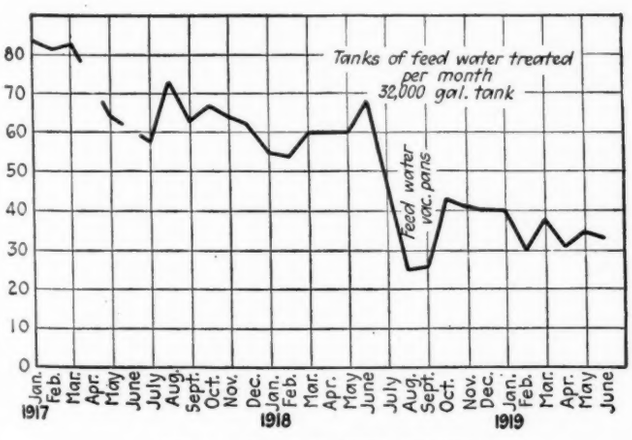


FIG. 3. FEED-WATER CHART

building. By adding some equipment to it, we were able to concentrate all the work therein and shut dowr the ovens in the old building.

Upon further study of the oven operation it developed that in order to prevent overheating openings of considerable area were left in oven doors. It was found that the proper temperature could be obtained with these openings closed if steam pressure was reduced to 20 lb., and so a reducing valve was put in thus making a big cut in the steam used per oven.

Considerable saving was accomplished by changing the layout of the steam-distributing mains, which in places had become quite complicated. In one case one new steam main with short branches replaced three oversized mains.

Fig. 3 shows the number of tanks of water treated per month. Unfortunately, our log of changing conditions is not complete and we are unable to explain many

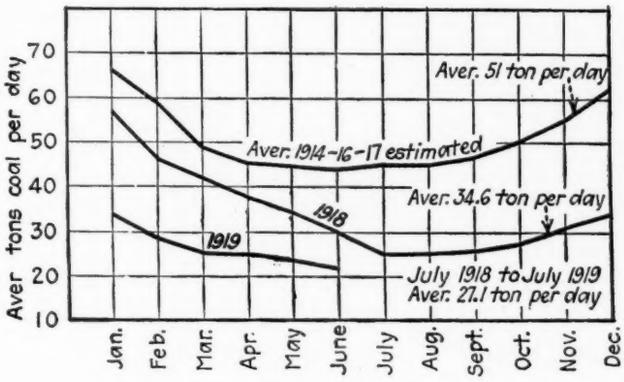


FIG. 4. COAL-CONSUMPTION CHART

of the fluctuations in the curve. The inverted tank was installed in August, 1917, and the boiler feed water was often used in the tube cleaner. August, September, October, November and December, 1917, show the effect of boiler cleaning. In March, April, May and July, 1918, some of the condensate was used in plant processes where hot water was required. In August and September we tried turning some of the water coming over from the vacuum pan into the make-up water. Tests of samples of feed water so obtained showed that the soda ash had neutralized the small amount of acetic acid in the vacuum-pan water, and in our chemist's opinion the water was fit for boiler feed. We were not satisfied with its behavior and made the following test: Two pieces of boiler tube were weighed and placed, one in treated water and the other in a sample of feed water made up of a mixture of vacuum, treated, and return water. After 48 hours there was no change in weight of the pieces, which were replaced in their respective baths and heat applied for 48 hours. The piece of tube in the treated water still showed no change, but the piece in the mixture containing vacuum pan water had lost weight, and its use as feed water was discontinued.

Trend of Coal Consumption

On the whole the curve shows the general trend of the coal consumption of the plant during the period covered. The average coal consumption for the three normal business years preceding the putting into effect of the changes described, was 18,593 tons with a maximum variation from this average of 290 tons. Curve 1914-16-17, Fig. 4, gives the estimated distribution of the coal over the corresponding years in average tons burned per day, and probably errs on the side of too much in the warm months and not enough in the cold.

Curve 1918, from January to June, was made up from monthly records of coal received and in stock. Our weighing larry went into commission the latter part of June, and from then on daily records were made. Some of the incidents contributing to the fall of curve 1918, January to July, are: Cutting over from high to low

pressure the greater part of the 8,000 ft. of radiation, saving condensation, installing soot blowers, replacing the feed-water heater the latter part of April (it had been out for repairs since early January), shutting steam off ovens of old building and reducing pressure on ovens of new building the first of July. In July a point was reached in plant conditions where the load was easily handled with one 6,500- and one 4,500-sq.ft. boiler. Only once in the next twelve months did we operate more than 11,000 sq.ft. of evaporative surface. During April, May and June of 1919 the plant production was above normal.

A plant may be the best-equipped in its line, but unless eternal vigilance is used in setting and maintaining high standards in every detail of operation, you will find two men doing one man's work with increased cost and loss of efficiency. Every manufacturing plant using much power, light or heat in its processes would find it profitable to have a capable "treasurer" of these supplies, whose duty would be to scrutinize every expenditure to see that full value was returned and that waste was reduced to a minimum. Some of these supplies are at the elbow of every operator. He simply has to turn a switch or a valve. It is often more convenient to open a window than to close a valve, especially if the valve happens to leak. To the individual operator the supply often seems inexhaustible and as free as the outdoor air.

With the exception of the ovens the engineer's department operated all the radiation for heating and drying. Heads of departments reported their requirements to the engineer and he saw that they got them. One of the operators made the rounds of the plant the first thing in the morning and the last thing at night, adjusting the heat and caring for any small leaks, defective traps, etc. The night force was kept in touch with conditions by the reports on temperatures of various departments, handed in at the end of each watchman's round. This proved a large factor in preventing waste and in keeping the lines tight.

Use of Auxiliary Air Jets With Underfeed Stokers

THE report of the Prime Movers Committee, Technical National Section, presented at the Forty-fourth Convention of the National Electric Light Association, shows how a member company of the N. E. L. A. remedied a bad case of erosion in the front wall of a furnace using an underfeed stoker. Fig. 1 clearly shows this erosive effect, which was caused by a diversion of the blast from the tuyère opening back and against the front wall at a point above and between the tuyères. The damaged back wall was removed, but before erecting a new wall auxiliary air ports made up of half-inch pipe fittings were located as shown in Fig. 2 to supply jets of air from the main wind-box at points and in the direction calculated to counteract the effect of the blast. Fig. 3 shows the results obtained in the use of these auxiliary ports, the eroding action having been practically eliminated. In Fig. 3 the jet openings are, of course, flush with the wall.

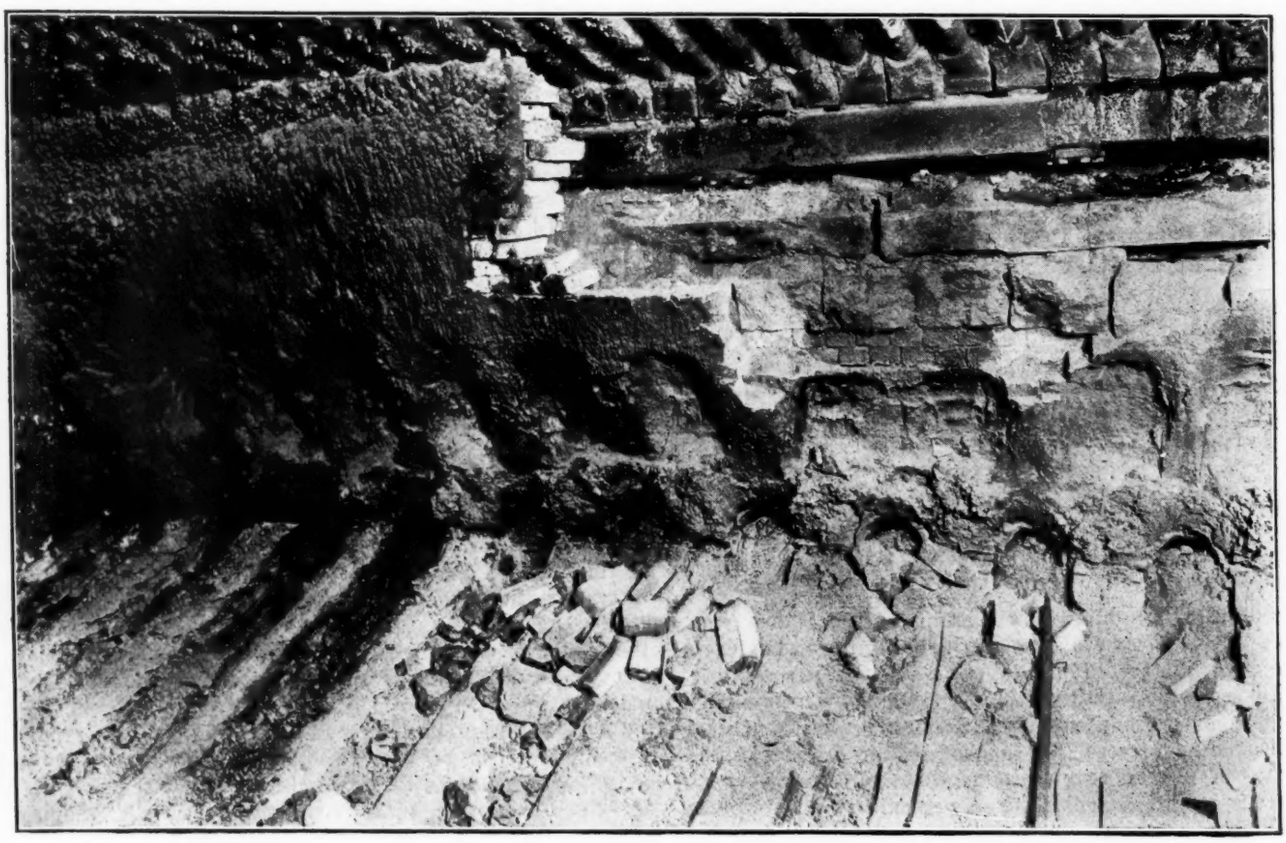


FIG. 1. EROSION OF BRICK WORK CAUSED BY TUYERE BLASTS DIVERTED AGAINST FRONT WALL

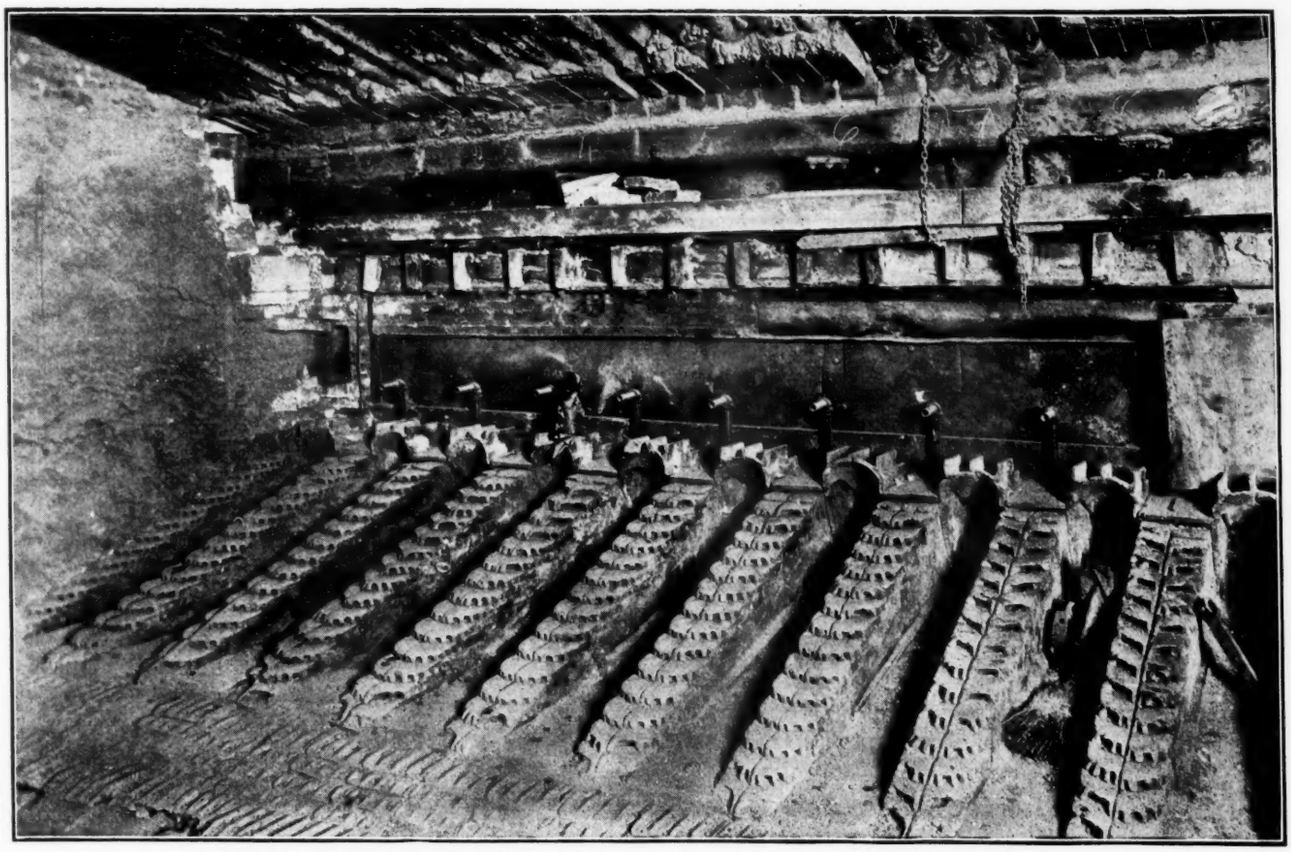


FIG. 2. PIPE JETS INSTALLED IN FRONT WALL TO REMEDY TROUBLE

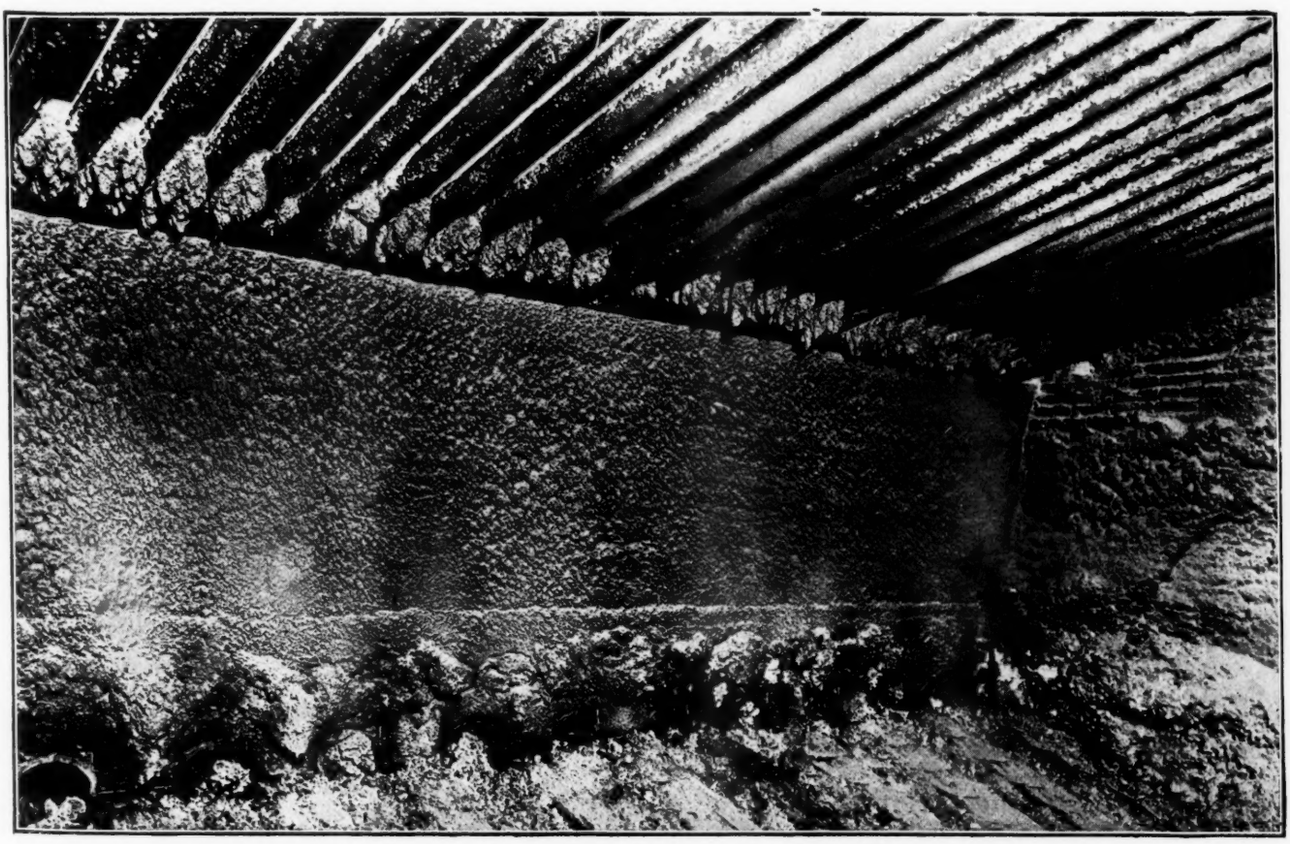


FIG. 3. FRONT WALL AFTER USE WITH AIR JETS SHOWING ABSENCE OF EROSION

Electric Elevator Machinery—Car Safeties

By M. A. MYERS
Electrical Engineer, The Maintenance Company, New York City

IN MODERN elevators the safety is located beneath the car, the combination of safety device, safety heads and channel irons forming the bottom element of the "safety girdle" and known as the "safety plank." Safeties may be of the instantaneous or clamp type for speeds under 200 ft. per min. or gradual or compression type for car speeds over 200 ft. per minute. A single eccentric safety of the former class, for light duty cars,

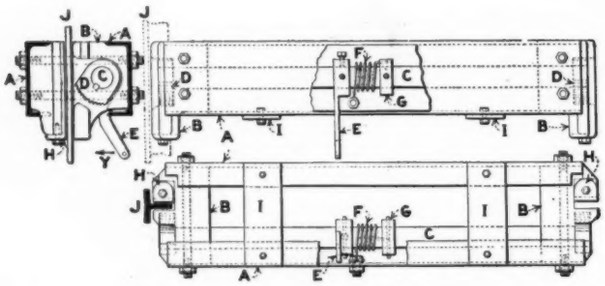


FIG. 1. INSTANTANEOUS SAFETY WITH SINGLE GRIPPING ECCENTRICS

is presented in Fig. 1. *A* and *A* are the channel irons and are bolted to the safety heads *B* and *B* by through bolts as shown. The safety heads are heavy castings and are provided with renewable brass wearing plates, or gibs *H*, converting them into combination safety heads and guide shoes. *C* is the rocker shaft, on either end of which are keyed the gripping eccentrics *D* and *D*. *E* is the tripping lever, *F* a torsion spring for holding the rocker in position and for bringing it back to position when the safety is released, one end of the spring being fast to the collar *G*, pinned to the rocker shaft, and the other end bolted to the channel-iron frame. *I* and *I* are bumper plates and *J* the steel guide rails.

When the governor sets from overspeed and locks the governor cable so that it cannot travel with the car, it is pulled out of the releasing carrier, as described in the article "Overspeed Governors," July 12 issue. The tail cable, being fast to the releasing carrier, also becomes stationary and the falling car causes lever *E*, to which the tail rope is fastened, to be jerked in the direction of the arrow *Y*. The gripping eccentrics are thus rocked upward, and the instant their corrugated edges come in contact with the guide rails, they are carried the remaining distance by the motion of the car itself, relieving the tail rope of any further duty. The gibs *H* are pulled against the guide rails and the eccentric locks the car.

Heavy-Duty Double-Eccentric Safety

Fig. 2 shows a heavy-duty double-eccentric instantaneous safety. It has two rocker shafts *C* and *C'* with eccentrics *D* and *D'*, instead of one. The motions of the two shafts are synchronized by the keyed segmental geared sheaves *E* and *E'*. A tripping chain *H* working in the groove of one of the sheaves is utilized to set the safeties instead of the tripping lever of Fig. 1. *K* and *K* are guide shoes bolted to the safety plank. The action is identical with that of Fig. 1, the guide rails being gripped by the double eccentrics instead of between a single eccentric and gib.

To release the car after either of the foreging types of safeties has set, it is only necessary to wind the hoisting cables back on the drum, taking up the slack slowly and carefully. Then raise the car by holding the brake open and using a spanner wrench or bar, usually provided for the purpose, on the brake coupling to turn the worm shaft. The lifting may also be done by working the controller by hand, first blocking open the accelerating device, but this method is liable to be abrupt, imposing a severe strain on the cables. As the car lifts, the eccentrics will roll downward until free of the guide rails, when they will be snapped in place by the torsion spring. After the governor gripping jaws have been released, the governor cable is restored to its anchorage in the releasing carrier. The reason for the setting of the safety, if other than the parting of the hoisting cables, must be ferreted out and the cause removed. The guide rails should also be examined to determine if roughening, displacement or other damage was done.

Compression-Type Safety

A gradual or compression-type safety is shown in Figs. 3 and 4. *A* and *A* are channel irons bolted to the safety heads *K* and *K*. *B* is the safety drum, keyed at *C* to the drawbar *F*, and provided with a cylindrical extension with holes *D* and *D* for releasing purposes. *E* and *E* are bearing brackets. The drawbar *F* is threaded at either end, right and left hand, the ends screwing into heavy wedges *G* and *G*. The four parts *I* are the

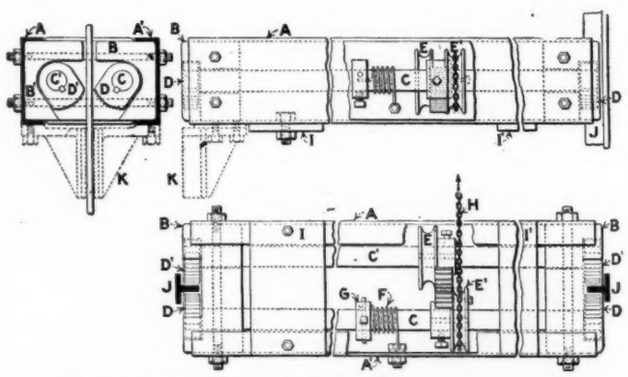


FIG. 2. INSTANTANEOUS SAFETY WITH DOUBLE GRIPPING ECCENTRICS

heavy main safety levers pivoted at *J* by heavy pins and provided at the inner ends with rollers *H*. The bottom safety levers and resetting spring are removed at the left for clearness. Pinned to the outer or short ends of the main levers are the gripping dogs *L*, with cross-grooved gripping surfaces. *M* is a tension resetting spring and *N* are holes for fastening the tension-roller frame, shown at *T* in Fig. 4. A fiber roller *R*, Fig. 4, is held against the tail rope wound on the safety drum, by four spiral springs, and its function is to prevent the drum from unwinding by vibration, to prevent snarling of the tail rope when the safety has operated

and to aid in releasing the safety. *P* and *P* are the bumper plates and *R* holes for bolting on the guide shoes. The action of this safety is as follows:

When the governor cables, and consequently the tail rope, are locked, the dropping car unwinds the cable off the safety drum. This action causes the drawbars to turn and screw into wedges *G*, drawing the latter toward each other, their tapered faces entering between the rollers *H*. The safety levers are therefore spread apart at their inner ends and, rocking on their pivots *J*, force the gripping dogs *L* toward each other against the guide rails. The pressure increases until the increasing friction between the dogs and the rails overcomes the car momentum and the car comes to a stop in about 6 to 8 ft. after the setting of the governor.

To release the car, the car-hoisting cables are replaced on the machine drum and the slack taken up. The governor gripping jaws are released and latched. A small opening in the floor of the car is uncovered and a short bar used in the holes *D* and *D* to wind the safety drum. When the wedges are thus unscrewed back to their original positions, the springs *M* restore the safety levers pulling the gripping dogs away from the

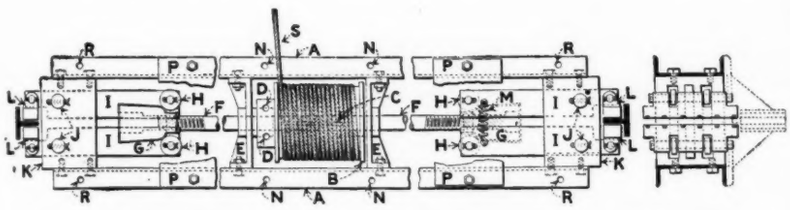


FIG. 3. PARTS AND ASSEMBLY OF COMPRESSION-TYPE SAFETY

guide rails. The three safeties just described are manufactured by the Wheeler-McDowell Elevator Co.

An A. B. See safety shown in Fig. 5 has an action similar to the one just described, with the exception that a rope-and-tackle scheme is used instead of the drum and drawbar. The tail rope *S* is wound about a series of tackle sheaves *B* and *B'*, each set consisting of about five sheaves. When the tail rope is held by the action of the governor, the falling car causes the two sets of

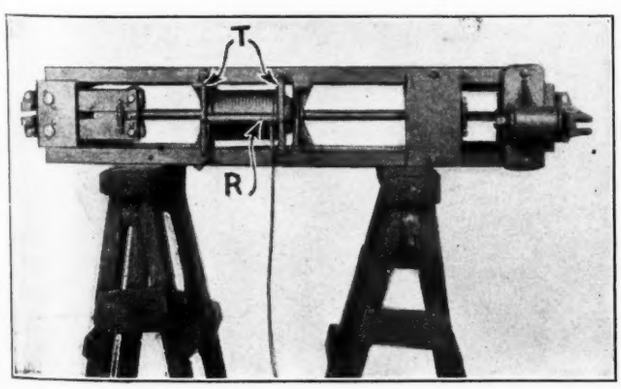


FIG. 4. COMPRESSION-TYPE SAFETY, SAME AS FIG. 3

sheaves to be drawn toward each other and along with them wedges *G* and *G'*, after which the action is precisely as that described in the previous paragraph. *F* and *F'* are resetting rods fast at the outer end to the tackle-sheave yokes, the inner or free ends sliding in grooves in the casting *E*. The free ends are provided with notches *C* on the upper surface. To release this safety, after the hoisting ropes are wound upon the drum and taking the weight of the car, the tail rope is pulled down to gain slack and the weighted governor sheave in the pit is blocked up to ease the operation. A special flat bar wrench is inserted through an oblong opening in the floor of the car directly over *E*, the end

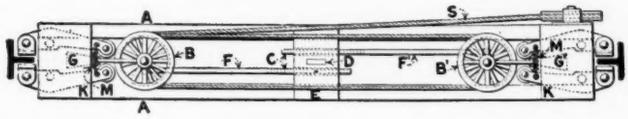


FIG. 5. A. B. SEE COMPRESSION-TYPE SAFETY

of the bar projecting through the rectangular opening *D* in *E*. When the bar is rocked, attachments on either side of it engage the teeth *C*, forcing the bars, and therefore the tackle sheaves, in opposite directions. Repetition of this operation forces the wedges from between the rollers and the tension springs *M* restore the main safety levers to their off position, thus freeing the car.

Fig. 6 shows an Otis Elevator Co. safety known as the "Flexible Guide-Clamp Type." It consists of two heavy jaws *A* and *B* pivoted at *C*. Jaw *B* is provided with a wedge *D* and a loose cylindrical serrated roller *E*, normally held in position at the lower or thin end of the wedge as shown. When the governor sets and the lever *F* is rocked upward by the action of the tail rope on the rocker shaft *G*, the roller is carried upward until it is brought into contact with the guide rail. The motion of the car then continues the upward progress of the roller between the rail and the inclined face of the wedge. Jaw *A* is pulled against the rail, and as the roller continues upward the heavy adjustable spring *H* is compressed until the pressure between *A* and the roller against the rail grows sufficient to overcome the momentum of the car, bringing it to a stop. This

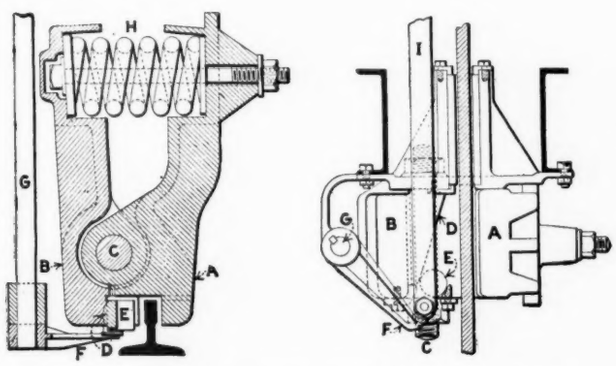
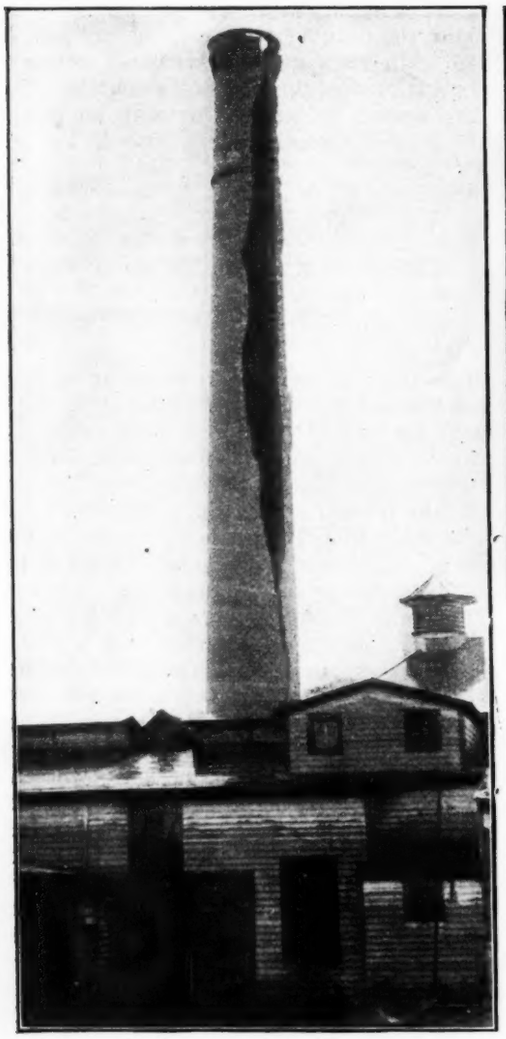


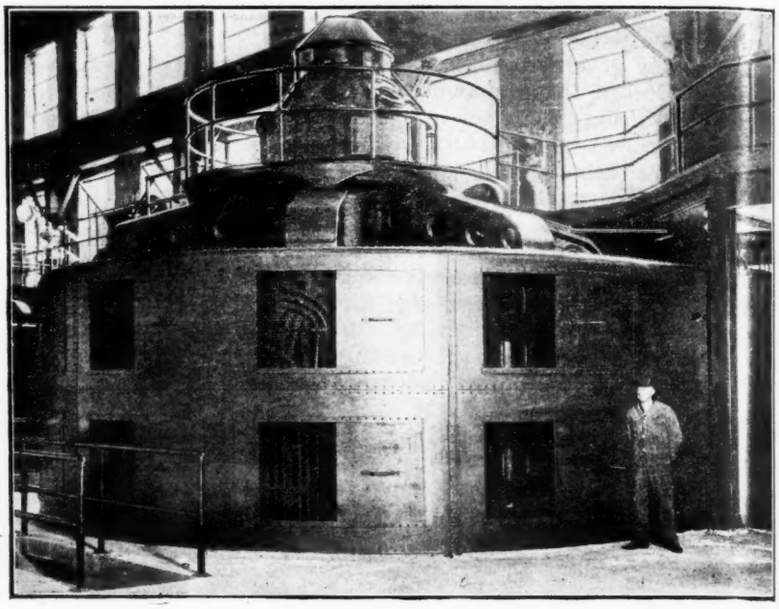
FIG. 6. FLEXIBLE GUIDE-CLAMP TYPE SAFETY

safety is released similarly to the instantaneous safeties previously described. A flat rod *I* extending to the top of the car is arranged to pull up lever *F* with the roller in case of the breaking of the hoisting cables, without waiting for the governor to act.

There are many other types of car safeties, but most all of them are on the same general principles as described in the foregoing. In some cases when the governor operates, it opens the power switch.

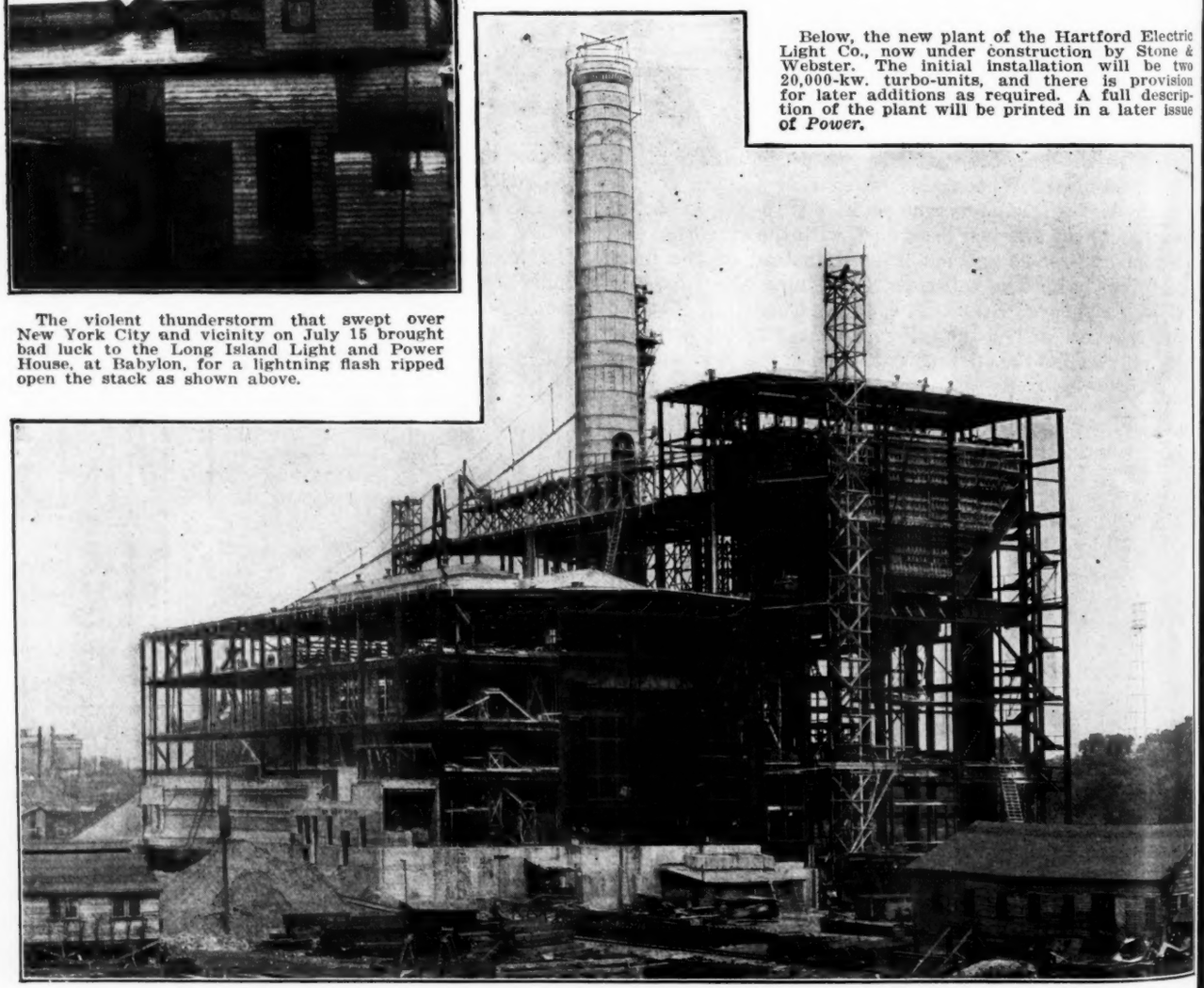


The violent thunderstorm that swept over New York City and vicinity on July 15 brought bad luck to the Long Island Light and Power House, at Babylon, for a lightning flash ripped open the stack as shown above.



A view of the steel-plate housing recently installed on the 37,500-hp. generators at the Niagara Falls Power Co.'s plant No. 3. In summer the sliding doors can be closed and the heated air carried outdoors by fans, one for each generator. In winter part of the air can be let into the room for heating and the remainder discharged to the ice runs to keep them clear.

Below, the new plant of the Hartford Electric Light Co., now under construction by Stone & Webster. The initial installation will be two 20,000-kw. turbo-units, and there is provision for later additions as required. A full description of the plant will be printed in a later issue of *Power*.



Recooling the Lubricating Oil from Turbine Bearings and Reduction Gears

By S. E. DERBY

LUBRICATING oil from turbine bearings and reduction gears is used again and again and for this reason must be recooled in a definite and positive manner, as for example, in an oil cooler in which the hot oil is circulated around straight tubes through which cold water flows.

For the average turbine installation about 3 per cent of the total power generated is lost as heat in bearings

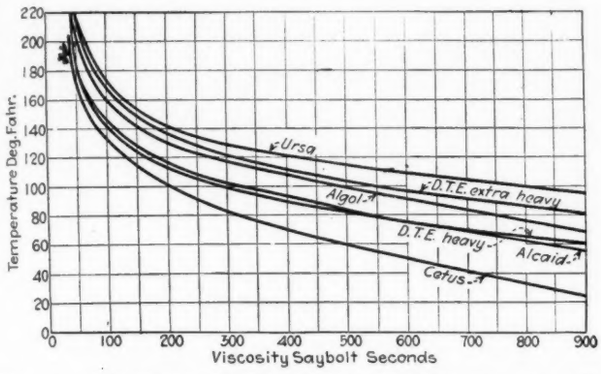


FIG. 1. RELATION BETWEEN TEMPERATURE AND VISCOSITY OF STEAM-TURBINE LUBRICATING OILS

and gears, and for installations without reduction gears about 1.5 per cent is lost as heat. Thus, in the case of a 3,000-hp. marine turbine with reduction gears, the equivalent heat value of the power is 7,635,000 B.t.u. per hour. Three per cent of this amount is 229.050 B.t.u., which is the heat developed per hour in the bearings and gears that must be absorbed by the lubricating oil and surrendered to the cooler. This is equal to 3,816 B.t.u. per min. If an oil circulation of 50 gal. per min. is required when the oil is at the temperature corresponding to the correct viscosity for lubricating the bearings and gears, and the viscosity of the oil is 107 Saybolt seconds at 130 deg. F. (the assumed bearing temperature), the cooling can be found as follows if the specific heat of the oil is 0.5:

$$50 \times 7.4 \times 0.5 \times X = 3{,}818$$
$$X = 20.6$$

That is, it will be necesary to cool the oil in the cooler from about 140 deg. F. to 120 deg. F.

Good practice is to circulate the oil through the bearings energetically and then to cool it in an oil cooler to a temperature below the normal operating temperature of the bearings. According to tests conducted by some of the leading turbine manufacturers, this bearing temperature is around 160 deg. F.

Cold Oil Does Not Produce Best Results

Relatively cold oil does not produce the best lubricating and cooling results. Cold oil is less fluid, and for this reason the oil particles which are in contact with the bearing surfaces and which have absorbed their share of the heat do not move away fast enough, and therefore are not rapidly replaced by other colder particles of oil. Under these conditions most of the oil circulating through the bearing does not get into contact with the bearing surfaces at all, but passes along without absorbing any heat. The bearing may become heated to a point where the temperature difference between it and the oil film in direct contact is so large that heat is transferred by conduction from the bearing to the oil film. As a result a comparatively small portion of exceedingly hot oil mixes with the remaining larger quantity of cold oil, and there is established at the outlet of the bearing a low oil temperature which by no means indicates the temperature of the bearing itself. Indeed the temperature of the oil may be surprisingly low, whereas the temperature of the bearing may have reached the allowable maximum.

In efficient lubrication the bearing is kept cool not by establishing a low bearing-outlet oil temperature, but

TABLE I. OIL-COOLER TEST

Inlet Temp. of Water, Deg. F.	Inlet Temp. of Oil, Deg. F.	Outlet Temp. of Oil, Deg. F.	Temp. Drop of Oil, Deg. F.
85	156	118	38
70	140	103	37
60	128	93	35
50	116	83	33
40	104	73	31

by bringing into contact with the bearing surfaces as many particles of oil per unit of time as possible. The particular oil temperature at which the turbine operates most efficiently should be maintained irrespective of the oil or water temperatures in the oil cooler. The temperature of the cooling water can be closely controlled by regulating the amount of water passing through the cooler.

The data in Table I are taken from a test on a Schütte & Koerting oil cooler in which 60 gal. of heavy

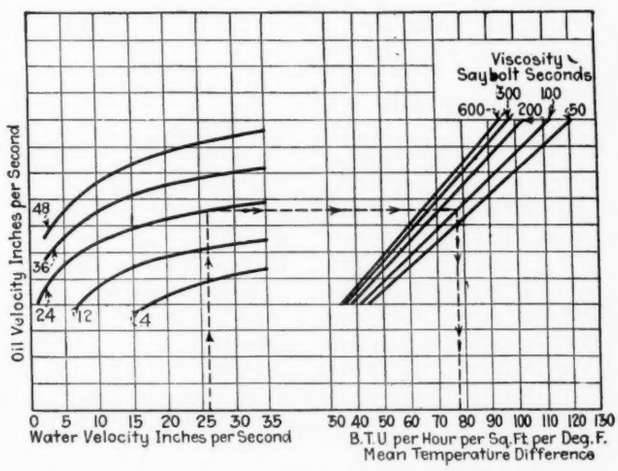


FIG. 2. CHART FOR DETERMINING COEFFICIENT OF HEAT TRANSFER IN OIL COOLER

Texaco Ursa oil was cooled per minute with 160 gal. of cooling water.

It is seen that the difference between water-inlet and oil-outlet temperatures is 33 deg. F. in every instance. Furthermore, the temperature drop in the oil decreases with the inlet-oil temperature. This is due to the fact that as its temperature diminishes, the oil becomes

thicker and more viscous, and its movement along the cooling surfaces becomes sluggish. For this reason cooling is retarded. The extent to which the viscosity increases with diminishing temperatures for various grades of turbine lubricating oil is shown by Fig. 1.

It is better to use a large quantity of oil recooled through a small temperature range than a smaller

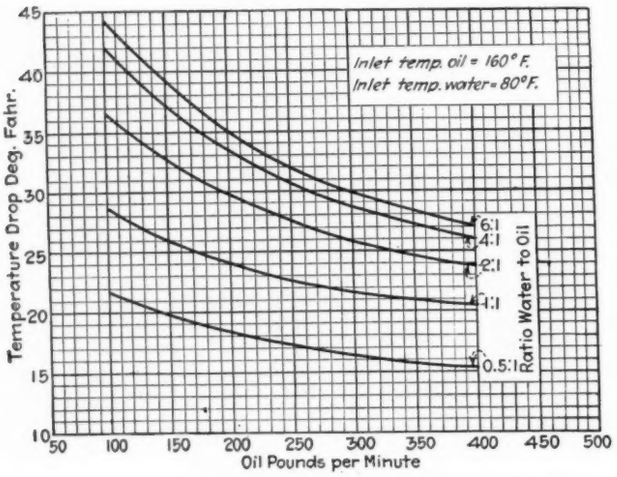


FIG. 3. VARIATION OF TEMPERATURE DRIP WITH FLOW OF OIL AND WATER FOR TYPICAL COOLER

quantity cooled through a large range. Cold oil, because of its greater viscosity and lower specific heat, cannot absorb the heat as well as oil at a high temperature. The variation of specific heat with temperature is shown by Table II for Texaco Ursa oil.

TABLE II. SPECIFIC HEAT OF TEXACO URSA OIL

Temperature of Oil, Deg. F.	Specific Heat of Oil, B.t.u. per Lb. per Deg. F.
100	0.437
120	0.450
140	0.462
160	0.474
180	0.486
200	0.497
220	0.508
240	0.518
260	0.527

According to the experience of the writer an oil-temperature drop of 30 deg. F. from 150 deg. F. to 120 deg. F. is preferable for stationary service. Under these conditions the oil flow in the bearings is vigorous and a thin oil film is formed that insures a rapid absorption of heat.

Heat-Transfer Rate in Oil Cooler

The heat-transfer rate in the oil cooler (the heat in B.t.u. transferred per hour per square foot of cooling surface per degree F. mean temperature difference between oil and water) depends on the velocity and viscosity of the oil, the velocity of the water, the arrangement of the cooling surfaces, etc. For this reason it is practically impossible to use any fixed heat-transfer rate in designing an oil cooler. A cooler that will handle 100 gal. per min. of a certain grade of oil having a viscosity of 250 Saybolt seconds at 120 deg. F. will cool, through the same temperature range and with the same water conditions, only about 75 per cent as much, or 75 gal. per min., of another grade of oil having a viscosity of about 750 Saybolt seconds at the same temperature.

Increased velocity of circulation increases the heat-transfer rate, but also increases the friction drop of the oil and water. However, since a high heat-transfer rate decreases the amount of cooling surface required, modern efficient oil coolers are designed with as high a velocity of the oil and water as is possible without causing an excessive drop due to friction.

Figs. 2 and 3 show some interesting relations between the heat-transfer rate, oil viscosity and water-to-oil ratios. If, for example, the oil viscosity is 100 Saybolt seconds, the oil and water velocities 24 and 26 ft. per sec. respectively, the heat-transfer rate corrected for oil viscosity is 77 B.t.u. This is found by entering the horizontal axis of the left side of Fig. 2 at 26, proceeding vertically to the 24 in. per sec. oil-velocity curve, then horizontally to the 100 Saybolt second oil-viscosity curve, and finally vertically downward to the horizontal axis. The point of intersection gives 77 B.t.u. as the value of the heat-transfer rate under the given conditions corrected for oil viscosity.

Increase in Water to Oil Ratio

There is a practical limit beyond which it is not advisable to increase the water-to-oil ratio (weight of water circulated per unit time to weight of oil circulated per unit time), since the increase in temperature drop is not at all commensurate with the increase in quantity of circulating water. This is illustrated by Fig. 3, which shows the characteristics of a certain cooler with an oil-inlet temperature of 160 deg. F. and a

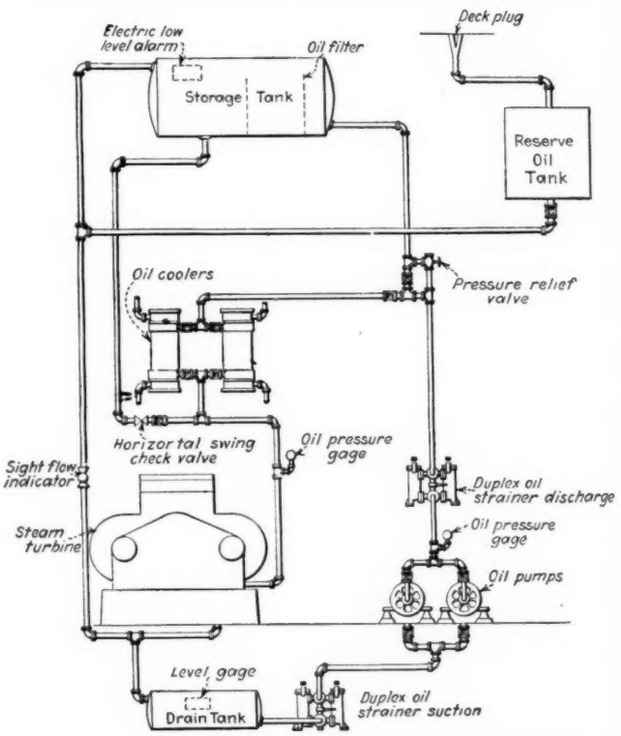


FIG. 4. LUBRICATING SYSTEM FOR MARINE-TURBINE INSTALLATION

water-inlet temperature of 80 deg. F. When, for example, 300 lb. of oil is passed through this cooler per minute the temperature drop is 16.5, 21.5, 26, 28.5 and 30 deg. F. for water-to-oil ratios respectively of 1 to 2, 1 to 1, 2 to 1, 4 to 1 and 6 to 1. Thus, increasing the water-to-oil ratio twelve times corresponds to only a fourteen-degree increase in temperature drop, or about twice the temperature drop for a 1 to 2 water to oil ratio.

A complete lubricating-oil system for a marine-turbine installation is shown in Fig. 4. This is the pressure-gravity combination system used on ships of the International Shipbuilding Corporation.

Oil from the drain tank is forced by either of two oil pumps through duplex oil strainers (which remove impurities such as casting sand, pipe scale, metal particles, dust, dirt, etc., in the oil) and is then passed to the oil cooler. Thence it is discharged to the turbine bearings and reduction gears. From the bearings and

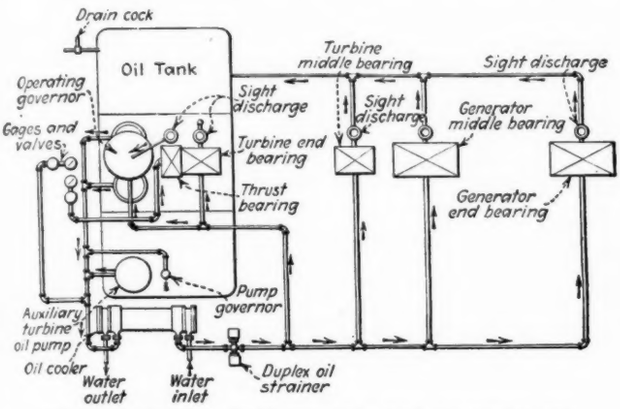


FIG. 5. LUBRICATING SYSTEM FOR STATIONARY-TURBINE INSTALLATION

gears it flows to the drain tank, thus completing the circuit.

The pumps are run so that more oil is circulated than is required by the bearings. The excess passes through a pressure-relief valve to a filter and storage tank. From there a line leads through a horizontal swing check valve to the oil-supply pipe connecting to the bearings. As long as the oil pressure is maintained in the cooler, this swing check valve remains closed. Should the pressure fall, however, owing to clogging up of the system or shutting down of the pumps, the valve opens and permits oil to flow directly from the storage tank to the bearings and gears. The overflow from the tank flows by an independent pipe line directly to the drain tank. As is shown, oil is held in reserve in a reserve oil tank which is filled through the deck plug.

Since a geared turbine ship could not run without adequate provision for recooling the lubricating oil, the oil cooler is installed in duplicate, one unit being available for emergency purposes.

A typical arrangement for a stationary turbine installation is shown in Fig. 5. The lower portion of the governor spindle drives a rotary oil pump which forces oil from the oil tank to the oil cooler and thence to the bearings. A spring-loaded relief valve on the line permits the excess oil to flow to the storage tank. From the bearings the oil flows through a strainer to the drain tank. Should the oil pressure go down, a piston in the governor gear normally held up by the pump pressure falls, thus shutting off the steam supply to the turbine and bringing the turbine to a complete stop before any damage is done.

Under no circumstances should a boiler be "cut-in" with other boilers unless the pressure within it is the same as that in the main. Before opening the boiler stop valve or header valve, be sure that there is no water in the length of pipe between these two valves.

The Chilling of Condensate

BY C. HAROLD BERRY

In a surface condenser steam is condensed in contact with metal surfaces which are maintained at a temperature lower than that of the steam by several or many degrees. If the condensate is allowed to

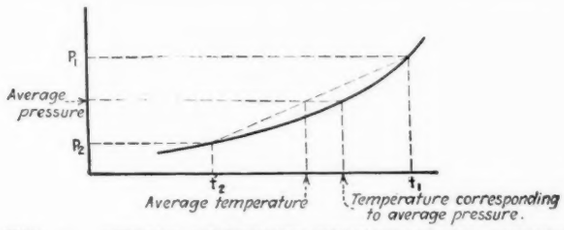


FIG. 1. STEAM PRESSURE-TEMPERATURE CURVE

remain in contact with these cold surfaces, it will be cooled below the steam temperature, an effect in no way useful and altogether undesirable, since this loss of temperature must be made good from some source of heat that costs money. The ideal surface condenser will discharge condensate at the temperature corre-

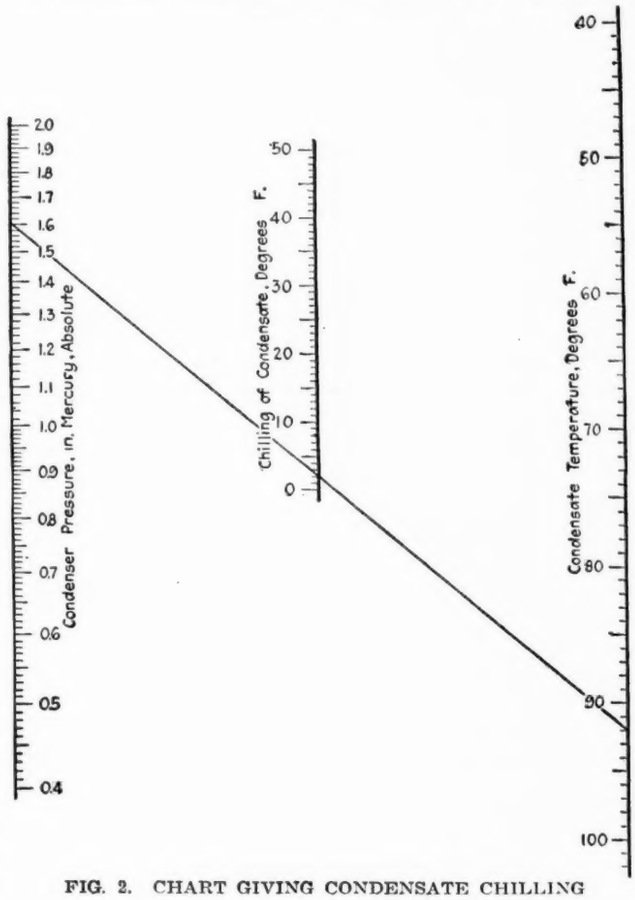


FIG. 2. CHART GIVING CONDENSATE CHILLING

sponding to the pressure prevailing in the condenser; that is, at the boiling point for that pressure. A measure of the extent to which a real condenser departs from this ideal is the so-called chilling of the condensate, which is merely the number of degrees by which the condensate, as it leaves the condenser, is below the boiling point corresponding to the condenser pressure.

In a properly designed surface condenser this quantity should be very small. In a surface condenser of

the so-called counter-current type the condensate drops back through the incoming steam, which enters the condenser at the bottom, and thus the condensate is warmed by the steam, and the chilling of the condensate is usually zero or nearly so; that is, the condensate is at the highest temperature possible at the prevailing condenser pressure. On the other hand, when steam enters a surface condenser at the top, the condensate drips from tube to tube, to the bottom, where the "atmosphere" is very largely air, with no great heating effect on the water. In such condensers excessive chilling of the condensate is often in evidence. This can be avoided by the use of properly arranged drain plates, which catch the condensate and conduct it through pipes to the bottom of the condenser shell or to the hotwell without contact with cold surfaces.

If it is desired to make an adequate study of the behavior of a surface condenser in this respect, it is necessary to compute this quantity for regular periodic readings of pressure and temperature. It is not correct to average the condenser pressure and the condensate temperature and to compute the result from these averages, because the boiling temperature corresponding to the average pressure is always greater than the average of the boiling points corresponding to the several pressures. This is due to the fact that the pressure-temperature curve for steam is not a straight line, as is shown in Fig. 1. A study of averages of hourly readings for an entire month indicates that this error will, in some cases, amount to several degrees. Even though it were only of the order of one degree, it would still be objectionable, since our object is to study the chilling of the condensate, a quantity amounting to only a few degrees in a properly operating condenser. The result computed from average pressure and temperature is always too large.

This chilling of the condensate is easily computed as follows: (a) For the absolute condenser pressure find the corresponding boiling temperature. This may be found from steam tables or curves or from the pressure-temperature scales published in *Power*, May 18, 1920. (b) Subtract from this boiling temperature the actual condensate temperature. The result is the chilling of the condensate.

This computation, very simple in itself, becomes a rather heavy task when it must be carried through for a long series of readings, and for such cases two mechanical devices are presented here for lightening the labor and reducing the time required.

The first of these is the simple alignment chart, shown in Fig. 2. A straight line joining points on the two outer scales, corresponding respectively to the condenser pressure and the condensate temperature, will cut the middle scale in the point corresponding to the chilling of the condensate. The straight line may be an ordinary straight-line-edge or, better, a stretched thread or a straight line scratched on the lower side of a strip of transparent celluloid. This chart will prove useful for a moderate amount of use, but for an extended study a still better device is recommended. This is a special slide rule, illustrated in Fig. 3. The three scales that make up the rule are shown in Fig. 4. These can be pasted on strips of bristol board and assembled to complete the rule.

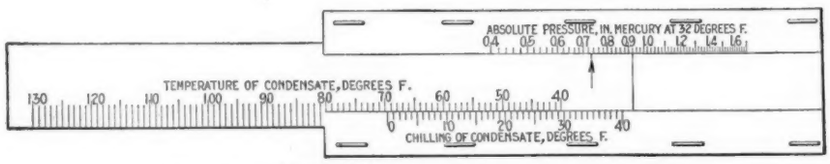

ABSOLUTE PRESSURE, IN. MERCURY AT 32 DEGREES F.
0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.2 1.4 1.6
TEMPERATURE OF CONDENSATE, DEGREES F.
130 120 110 100 90 80 70 60 50 40
0 10 20 30 40
CHILLING OF CONDENSATE, DEGREES F.

FIG. 3. CONDENSATE CHILLING SLIDE-RULE

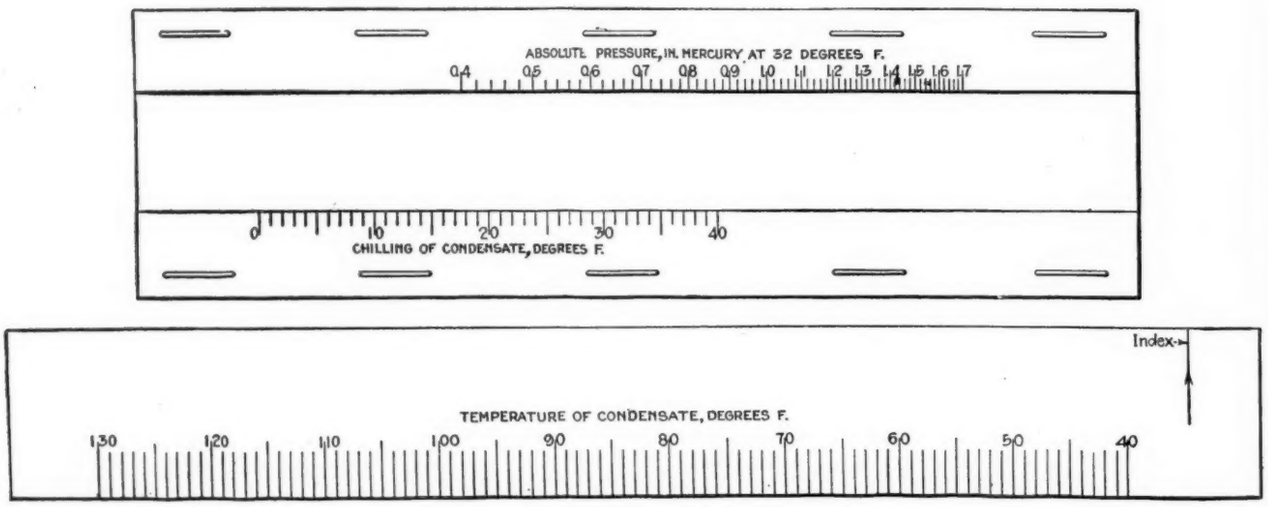

ABSOLUTE PRESSURE, IN. MERCURY AT 32 DEGREES F.
0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7
0 10 20 30 40
CHILLING OF CONDENSATE, DEGREES F.
Index
TEMPERATURE OF CONDENSATE, DEGREES F.
130 120 110 100 90 80 70 60 50 40

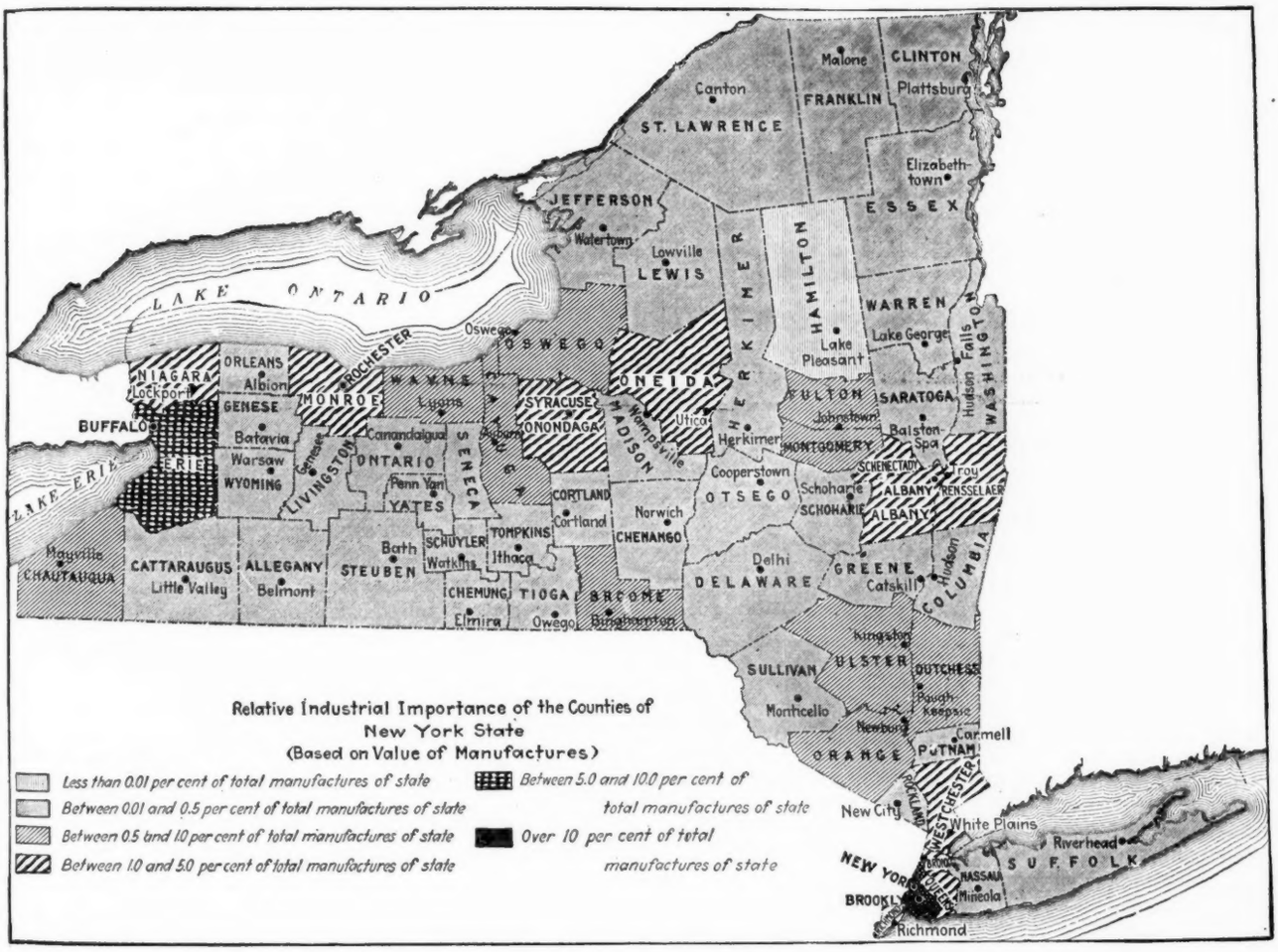
FIG. 4. SCALES FOR THE SLIDE RULE

The method of using the slide rule should be obvious. Set the slide index against the condenser pressure and opposite the condensate temperature read the degrees chilling of the condensate. For example, for a back pressure of 0.73 in. and a condensate temperature of 65 deg., the chilling is 4.6 deg. If many values are to be worked out, two people can work together to advantage, one reading pressures and temperatures and recording results, the other operating the slide rule.

Management Engineering makes its bow from the Ronald Press. Its announced purpose is "to serve those who are responsible for industry." L. P. Alford, its editor, has seen service as editor of the *American Machinist* and of *Industrial Management*. *Power* wishes the new comer an abundant success.

New York State Shows Large Increase in Industrial Power Load

INDUSTRIAL plants in New York State have shown a marked increase in the use of electricity during the last six years, the connected load alone having increased over 100 per cent, or from 836,000 hp. to 1,720,000 hp. The increase in electrical energy sold by central stations to power customers, exclusive of railroads has been even greater—from 1,071,840,000 kw.-hr. in 1914 to 3,058,000,000 kw-hr. in 1919, or 185 per cent. No statistics are yet available with regard to the increase in private generating plants during that period.



THE RELATIVE INDUSTRIAL IMPORTANCE OF THE VARIOUS COUNTIES OF THE STATE OF NEW YORK

In order to ascertain the use of electricity by the industries of New York State, over 8,000 questionnaires were sent out to the large manufacturing plants. The returns have been grouped under sixteen general industries as indicated in Table I.[1] Complete reports were received from 1,931 plants, of which 866 reported the use of electricity as the main source of power. The private plants reported a generating capacity of 204,585 hp., of which direct-current generators formed 64,211 hp. and alternating-current generators 140,374 hp. The total output in 1920 of these private generating plants was 552,135,082 kw.-hr. The electricity purchased by the plants reporting was 957,048,814 kw.-hr. A study of the returns indicates that about 54 per cent of the plants generating all or a portion of their electricity reported and that only about 25 per cent of those purchasing their electricity made reports.

An estimate of the total use of electricity in the industrial plants in New York State based upon the returns received in the survey supplemented by the Federal and State census, is contained in Table II. This indicates that there are 181,250 motors installed in the factories of the state with a total rating of 1,704,350 hp. Of these 35 per cent are under 5 hp., about 65 per cent are belt-driven, 30 per cent direct-connected and only 5 per cent employ chain drive.

There are over 5,200 plants in New York State having more than fifty operatives each; of which number nearly two-thirds are in Greater New York. The accompanying map indicates the relative industrial impor-

[1]The survey being conducted jointly by *Power* and *Electrical World* has already covered California (see *Power*, Sept. 21, 1920) and the Southern States (see *Power* June 28, 1921); data on other states or sections will be published as completed.

tance of the various counties based upon the value of manufactured products. New York City accounts for 65.4 per cent of the states' total manufactures.

The twelve primary industries of the state in order of importance are as follows: Textiles, paper and printing, iron and steel and their products, food and kindred products, tobacco manufactures, electrical-machinery apparatus and supplies, chemicals, leather manufactures, lumber and timber products, metal and metal products other than iron and steel, vehicles for land transportation, and railroad repair shops.

Textiles—The textile industry, which includes the manufacture of men's and women's clothing, hosiery and knit goods, silk goods, woolen and cotton goods, etc., is by far the most important industry in the State of New York not only in the value of product, but in persons employed therein. It is estimated that there are about 1,420 textile establishments in New York City employing over fifty operatives each and 458 such plants outside New York City. This industry is the second largest user of electrical energy in New York State, almost one-sixth of the motors in the industrial plants of the state being installed in textile plants. It consumed approximately 471,900,000 kw.-hr. in 1920, of which about 128,000,000 kw.-hr., or 27 per cent, was generated in private plants. The large amount of privately generated energy is rather surprising in view of the fact that a large proportion of the plants are in large cities where central-station service is readily available.

Paper and Printing—This industry includes the manufacture of paper and pulp, printing and publishing of all kinds, steel engraving and lithographing, and is the second industry in the state in value of products and the fourth in the number of wage earners. It consumed approximately 405,500,000 kw.-hr. of electricity in 1920, of which about one-third was generated in private plants. The average rating of the motors reported was 21 hp., and of the total about 40 per cent are under 5 hp. More than three-quarters of the motors used in this industry are belt-connected, 17 per cent are directly connected and 7 per cent are chain-driven.

TABLE I—SEGREGATION OF THE INDUSTRIAL LOAD IN THE STATE OF NEW YORK

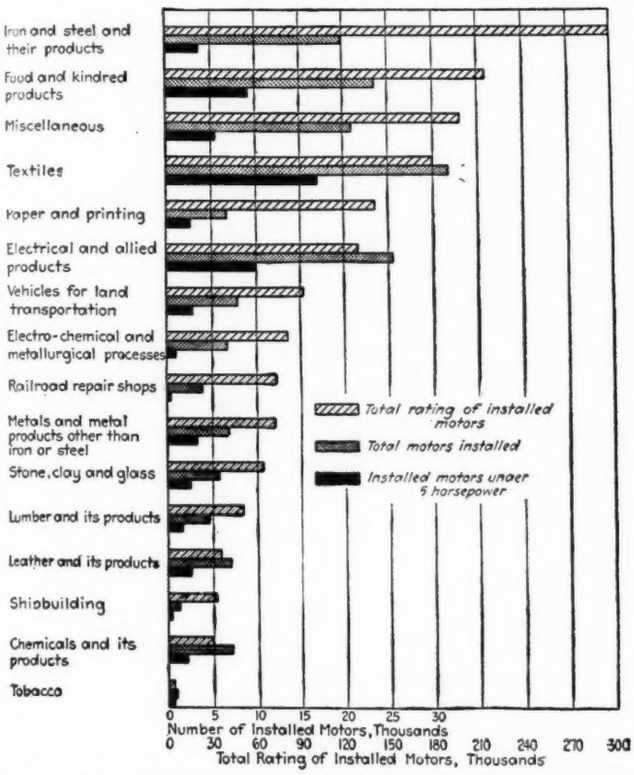
These data are compiled from an industrial survey being conducted by the McGraw-Hill Company, Inc., under the supervision of the Editorial Departments of *Power* and the *Electrical World* and cover plants in all industries employing more than fifty operatives

Industry	Companies Reporting		Electric Generators				Electrical Energy		Motors Installed			Distribution of Drives		
			Direct Current		Alternating Current									
	Total No.	Number Using Electrical Energy	No.	Total Rating Hp.	No.	Total Rating, Hp.	Generated, Kw.-Hr.	Purchased, Kw.-Hr.	No.	Total Rating, Hp.	No. Under 5 Hp.	Belt	Chain	Direct or Geared
Chemicals and allied products	80	40	40	2,745	9	1,716	19,997,205	5,259,399	1,367	5,712	380	1,000	59	308
Electrical equipment and machinery	28	20	13	4,008	7	33,443	58,026,310	61,633,890	15,091	76,062	5,872	13,300	31	1,760
Electrochemical and electrometallurgical processes	9	9	19	6,275	2	8,600	54,727,275	193,219,625	2,670	23,668	384	1,210	450	1,010
Food and kindred products	100	59	51	5,797	18	5,755	46,048,172	30,273,138	4,134	38,215	1,636	2,965	242	927
Iron and steel and their products	323	203	132	22,104	37	19,698	77,960,067	371,274,459	19,195	292,454	3,570	12,950	865	5,380
Leather and its products	37	23	15	628	9	9,463	29,732,636	5,367,199	3,637	18,250	1,262	3,478	84	75
Lumber and its products	143	78	39	2,477	19	5,795	18,457,828	8,388,802	2,071	22,134	664	1,470	120	481
Metals and metal products other than iron and steel	104	63	33	3,496	15	5,274	32,676,275	20,225,644	3,303	34,355	1,591	2,640	182	481
Paper and printing	105	67	32	3,213	27	21,922	101,613,480	90,411,264	3,226	67,792	1,278	2,460	231	535
Railroad repair shops	23	16	12	870	7	2,846	10,475,590	48,179,927	1,511	27,453	74	640	57	814
Shipbuilding	8	6	3	765	0	0	1,854,500	11,916,000	540	13,430	121	319	15	206
Stone, clay and glass	79	25	17	857	8	3,453	12,356,192	6,719,843	891	9,806	375	559	43	289
Textiles	401	204	78	7,278	48	20,122	73,935,678	93,325,958	11,312	63,784	6,049	4,820	622	5,870
Tobacco	10	7	4	75	2	195	99,000	1,277,296	230	988	154	135	0	95
Vehicles for land transportation	16	12	7	385	3	168	723,600	2,319,872	263	3,020	92	204	5	54
Miscellaneous	465	34	26	3,220	10	1,924	13,451,274	7,256,498	1,293	12,183	344	625	111	557
Totals for all industries in State	1,931	866	521	64,211	221	140,374	552,135,082	957,048,814	70,734	709,306	23,846	48,775	3,117	18,842

TABLE II—ESTIMATE OF THE USE OF ELECTRICAL ENERGY IN NEW YORK STATE (BASED ON INDUSTRIAL SURVEY, FEDERAL AND STATE CENSUS DATA)

Industry	Industrial Plants Generating Electrical Energy for Own Use			Industrial Plants Purchasing Electrical Energy			Total Electrical Energy Consumed By All Industrial Plants	Total Motors Installed			Distribution of Drives		
	Energy Generated, Kw.-Hr.	Motors Installed		Energy Purchased, Kw.-Hr.	Motors Installed		Kw.-Hr.	No.	Total Rating, Hp.	No. Under 5 Hp.	Belt	Chain	Direct or Connected
		No.	Total Rating, Hp.		No.	Total Rating, Hp.							
Chemicals and allied products	41,900,000	2,270	9,500	91,000,000	4,930	20,600	132,900,000	7,200	30,100	2,000	5,270	310	1,620
Electrical equipment and machinery	59,000,000	7,430	37,500	144,200,000	18,200	91,750	203,200,000	25,630	129,250	9,980	22,600	50	2,980
Electrochemical and electrometallurgical processes	55,000,000	592	5,250	1,700,000,000	6,160	76,500	1,755,000,000	6,752	81,750	970	3,060	1,142	2,550
Food and kindred products	162,300,000	8,780	81,200	271,700,000	14,730	136,200	434,000,000	23,510	217,400	9,300	16,850	1,380	5,280
Iron and steel and their product	78,300,000	3,340	51,000	384,000,000	16,500	251,300	462,300,000	19,840	302,300	3,670	13,390	890	5,560
Leather and its products	30,000,000	3,110	15,600	38,200,000	3,980	19,940	68,200,000	7,090	35,540	2,460	6,780	164	146
Lumber and its products	20,000,000	1,520	16,250	42,000,000	3,240	34,650	62,000,000	4,760	50,900	1,528	3,380	276	1,104
Metals and metal products other than iron and steel	33,000,000	1,978	20,590	79,850,000	4,980	51,770	112,800,000	6,958	72,360	3,350	5,560	385	1,013
Paper and printing	145,500,000	2,450	51,400	260,000,000	4,280	90,000	405,500,000	6,730	141,400	2,667	5,130	482	1,118
Railroad repair shops	54,700,000	1,410	25,600	102,800,000	2,660	48,240	157,500,000	4,070	73,840	192	1,720	153	2,197
Shipbuilding	1,900,000	70	1,850	31,100,000	1,220	30,370	33,000,000	1,290	32,220	289	763	36	491
Stone, clay and glass	57,400,000	2,680	29,500	68,000,000	3,160	34,900	125,400,000	5,840	64,400	2,455	3,660	284	1,896
Textiles	128,000,000	8,650	48,800	343,900,000	23,220	131,060	471,900,000	31,870	179,860	17,030	13,550	1,750	16,570
Tobacco	432,000	70	310	3,533,000	590	2,540	3,965,000	660	2,850	442	388	0	272
Vehicles for land transportation	5,500,000	480	5,460	87,900,000	7,600	87,260	93,400,000	8,080	92,720	2,830	6,460	154	1,670
Miscellaneous	149,500,000	9,350	88,000	186,000,000	11,620	109,460	335,500,000	20,970	197,460	5,575	10,140	1,800	9,030
Totals for all industries in State	1,022,432,000	54,180	487,810	3,834,133,000	127,070	1,216,540	4,856,565,000	181,250	1,704,350	64,738	118,701	9,256	53,497

Electrochemical and Electrometallurgical Industry—The chemical industry is now the largest user of electric power in the United States and ranks fourth in size as an industry. It has become one of the most important industries of New York State, being concentrated almost exclusively in the vicinity of Niagara Falls on account of the cheap hydro-electric power available at that place.


Iron and steel and their products
Food and kindred products
Miscellaneous
Textiles
Paper and printing
Electrical and allied products
Vehicles for land transportation
Electro-chemical and metallurgical processes
Railroad repair shops
Metals and metal products other than iron or steel
Stone, clay and glass
Lumber and its products
Leather and its products
Shipbuilding
Chemicals and its products
Tobacco
Total rating of installed motors
Total motors installed
Installed motors under 5 horsepower
0 5 10 15 20 25 30
Number of Installed Motors, Thousands
0 30 60 90 120 150 180 210 240 270 300
Total Rating of Installed Motors, Thousands

IRON AND STEEL INDUSTRY LEADS IN TOTAL RATING OF INSTALLED MOTORS

It is estimated that about 1,755,000,000 kw-hr. was consumed by this industry during 1920. This amount is approximately 36 per cent of the total consumed by the industries of the state and almost 8 per cent of the total electrical energy consumed by all industries in America. By far the greater proportion of electrical energy consumed in this industry is in connection with the operation of furnaces, the operation of motors being to a large extent auxiliary to the operation of these furnaces.

TABLE III—NUMBER OF PLANTS IN NEW YORK STATE HAVING MORE THAN 50 OPERATIVES

	Outside of New York City	Within New York City	Total in New York State
Chemicals and allied products	75	122	197
Electrical equipment and machinery	28	66	94
Food and kindred products	199	163	362
Iron and steel and their products	271	166	437
Leather and its products	128	117	245
Lumber and its products	177	161	338
Metals and metal products other than iron and steel	158	149	307
Paper and printing	128	298	426
Railroad repair shops	87	18	105
Shipbuilding	13	20	33
Stone, clay and glass	77	34	111
Textiles	458	1,420	1,878
Tobacco	26	78	104
Vehicles for land transportation	61	43	104
Miscellaneous	109	391	500

Railroad Repair Shops—There are 105 railroad repair shops in the state employing fifty or more operatives, of which 87 are outside of New York City. They contain over four thousand motors with a combined rating of nearly 75,000 hp. The motors used in this industry are mostly of large size, there being only 192 under 5 hp. More than half are directly connected to the machinery operated and they are used to operate machine tools, lathes, woodworking machines, air compressors, presses, planes, jointers, shapers, boring mills, threaders, saws, buffing wheels, cranes, fans, hoists and turntables.

Pointers on Electric-Power Rates

BY GEORGE MACLEAN

Three subjects that are frequently little understood among men who are responsible for the purchase of power for industrial plants are the flat rates, kilowatt-hours and maximum demand. A flat rate is based on the connected load. Assume an installation of several motors, amounting in all to 200 hp., and a rate of $40 per horsepower year is charged. Then the cost of power per month is $\frac{40 \times 200}{12} = \$666.66$ for the total connected load of 200 hp. The advantage or disadvantage of a rate of this kind depends on the load factor, or the ratio of the horsepower employed to the motor horsepower. From this it can be readily seen that if only 100 hp. of the total connected load of 200 hp. is being utilized, then the connected load factor is 50 per cent, or 50 per cent of the connected load is being paid for and produces no return. Thus if the contract is on a flat-rate basis, watch the motors and keep them loaded up to full load, if possible. Also, the processes should be arranged so as to keep all motors in service as much as possible, for when they are stopped the power expense is still going on.

The kilowatt-hour is the equivalent of 1,000 watts for one hour, or 1,000 watt-hours. This method of buying power has the advantage over the flat-rate system, in that only the power used is paid for. If on 200-hp. connected load only 100 kilowatt, or 134 hp., is used continuously for one hour, the power consumed is 100 kw.-hr. and this is what is paid for. The total 200 hp. is not paid for, as on the flat rate, but only for the actual power consumed by the motors.

Maximum demand presents a different problem than either the flat-rate or kilowatt-hour rate. A special meter is connected in the circuit, which automatically registers the highest amount of power used over a certain interval of time. If you have contracted for 200 hp. and the maximum demand does not exceed this, then only 200 hp. is paid for. However, if the maximum demand is 250 hp., say for 15 minutes, for any one day during the month, then 250 hp. is charged for. The reason for this is that the power company is supposed to have to hold in reserve sufficient capacity to meet the needs of the customer. It is evident that much can be done to keep the peak loads down by the proper manipulation and arrangement of machinery. For example, if there are a number of heavy processes that operate only intermittently, then, if it is possible to have different processes going on at different times, the load will be much lower than if all were in operation at once.

The maximum-demand rate can also be used in conjunction with a kilowatt-hour rate; that is, so much per kilowatt-hour is charged and in addition to this, so much per kilowatt maximum demand for a given interval during the month is also charged.

New Diamond Valv-In-Head Soot Blower

What is termed the Valv-In-Head soot blower, **Fig. 1**, has as a main feature a poppet type of valve that controls the individual unit and has been incorporated as an integral part of the head of the blower. This valve takes the place of the globe valve that has heretofore been used in the riser pipe leading from the main header.

Referring to Fig. 2, which shows a cross-section of the goose neck, the poppet valve is kept to its seat by a spring and is forced from its seat by a steel cam that is actuated as a result of revolving the sheave wheel by pulling on the chain shown in Fig. 1. On the sheave-wheel shaft is a pinion that meshes with a gear that carries a cam. As the sheave wheel is revolved, the gear wheel is revolved also and the cam causes the lever *A*, Fig. 1, to press down the valve stem, thus causing the valve to open at a predetermined point in the revolution of the cam. After the gear has been further rotated, the cam releases the lever and allows the steam pressure to close the valve at a second predetermined point in the revolution. As the steam leaves the line, the spring holds the valve tight. The

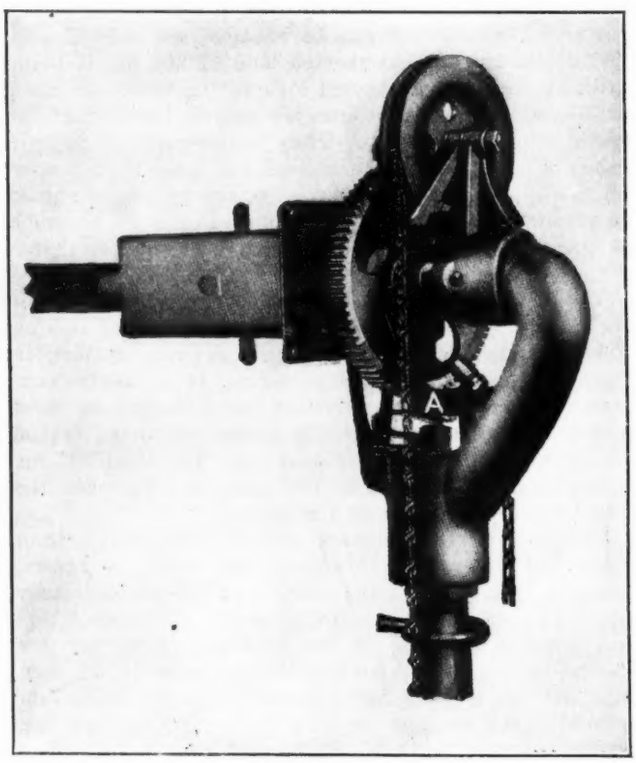


FIG. 1. EXTERIOR VIEW OF SOOT BLOWER HEAD

length and the relative position of the cam are individually determined for each unit at the time of installation.

Each blower head is provided with a vacuum breaker, to prevent the suction of gases into the blower element during the period when steam is off the unit. This vacuum breaker is made in the form of a small brass whistle which sounds during the time the blower is in operation. This visible and audible signal is a check on the operator, who might otherwise leave steam on the unit while not revolving the blower.

Guides prevent the hand chains from running off the sheave wheel, and ball bearings relieve the friction caused by the steam in passing through the unit. Any condensate in the main supply pipe is discharged through drain pipe before blowing begins, thus preventing flooding the jets.

The blower is so designed that the steam jets blow only when the nozzles are directed at parts of the boiler from which soot deposits are to be removed. Steam is automatically cut off from the blower element at the precise point in its revolution at which the jets will

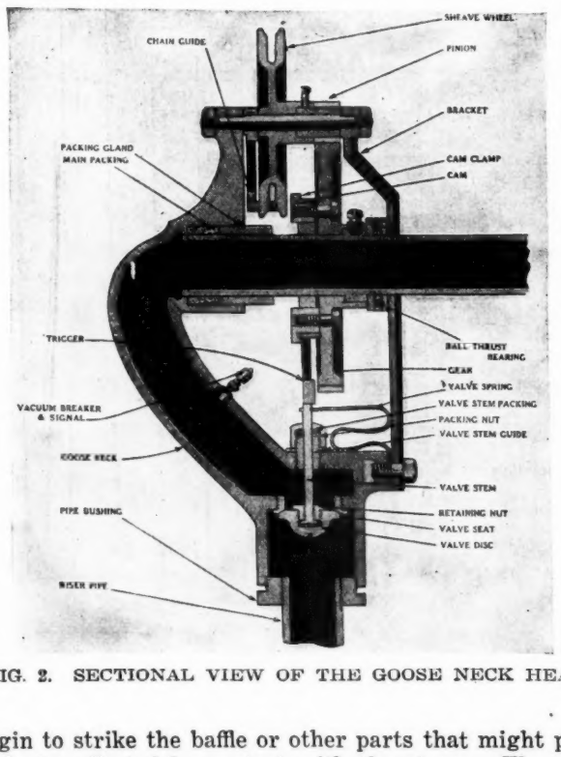


FIG. 2. SECTIONAL VIEW OF THE GOOSE NECK HEAD

begin to strike the baffle or other parts that might possibly be affected by contact with the steam. The cam may also be so constructed that steam can be turned on again when the jets have passed the baffle. As the gear reduction is designed with a ratio of 10 to 1, the speed of the soot-blower element is such as to give the proper time for blowing. The blower is manufactured by the Diamond Power Specialties Co., Detroit, Mich.

Solid lubricants such as mica, graphite and soapstone have great carrying power at low speeds, but their value depends as much on the nature of the surfaces. Graphite, for instance, gives the best results when used on cast-iron surfaces, which are naturally very porous and hold the graphite, but the frictional loss and wear are great. Solid lubricants mixed with animal fats, greases, vaseline or rosin oil are suitable for low speeds and heavy loads, as they give a low coefficient and do not waste away rapidly by evaporation nor run off the bearings. Greases compounded from animal and vegetable fats, or mineral oils emulsified with water soap and alkali enough to neutralize them, are good lubricants for slow-moving bearings with excessive loads, provided the oils do not contain too much water and are not adulterated with foreign substances; the oil should not run down and leave the soap, which is liable to occur in poorly made greases.

EDITORIALS

The Flesh Pots of Egypt

THINKING back to the times of cheap coal easily obtainable in any market of the size and quality desired, it is but human to sigh for these easy times of the pre-war period. But sighing does not make the steam cost any less, nor does talking about why coal should be cheaper or better, or this or that or any other thing.

Even with the memory of making bricks without straw the Israelites wandering in the wilderness sighed for the flesh pots of Egypt. The thought of a promised land did not seem to help them bear their troubles gracefully. It seems that the fuel user is in much the same situation today, and there is not much greater tendency to follow the modern Moses than in the early days of Hebrew tribulation. Nevertheless there is a promised land before the fuel user of today just as truly as there was awaiting at the end of the forty years' wandering in the wilderness, and it need not take the fuel user forty years to find the promised land either.

There are short cuts provided by modern machinery and methods which will quickly lead to a comfortable situation of low-cost steam despite unfavorably priced coal. One need only follow the Moses of efficient equipment and effective methods promptly to escape in part from those higher costs that have inevitably followed with rising prices of coal.

Very cheap coal is a thing of the past, at least for some years to come. Mine labor and transportation expense make coal at pre-war cost in the bunker wholly out of the question. To sigh for pre-war days, therefore, is futile. The proper procedure is to get busy and put the plant upon that engineering basis which it long ago should have attained; and then, despite the higher cost of materials and plant labor, the cost of steam (which is the thing which really counts) will not greatly exceed the former figures.

Humanizing Thermodynamics

THE mere name "thermodynamics" is enough to frighten almost anybody except the hardened theorist. It sounds like the sort of subject that is extremely difficult to master and then gets one nowhere in particular for his pains. Yet this subject of "Heat-Mechanics" ties together the two elements that are the very bread and butter of power-plant work. Every minute of the working day the operating engineer is busy with the complicated process of turning heat into "work" and keeping the "work" obtained with so much difficulty from "sliding back" into heat; for the latter process is as easy and natural as the former is difficult and artificial.

Much money must be spent for heat—in the form of coal or other fuel; yet the most elaborate apparatus operated with the greatest care can turn only a small part of it into work, while the remainder goes to waste unless there is some use for it in the form of heat. It is the engineer's constant care to use the minimum of heat to get the required amount of useful work. Although much can be accomplished by paying close attention to the dictates of experience, the possible combinations are so numerous that life is too short to find the right one by the cut-and-try method, while even experienced judgment, unaided, will often choose a combination that is far from the best obtainable.

Many an engineer comes to appreciate the fact that it would help him a lot to know *why* things happen in boilers, engines, turbines, steam pipes, feed-water heaters, condensers, economizers and other power-plant equipment. Fired with the thirst for this knowledge, he may start to study some standard book on thermodynamics. What he wants to know is probably in the book, but it may be harder to extract than gold from sea water. Perhaps the book was never written for the power-plant engineer, or it may be that a real though unsuccesful effort has been made to "put the message across." It is often the case that the man bright enough to write a book on thermodynamics is too bright to be understood by ordinary human beings. The frequent insertion of such phrases as "from this the following expression is easily derived" or "it is easily seen," only adds to the anger and despair of the thwarted seeker after knowledge who can neither "derive" nor "see," to say nothing of doing it "easily."

A few suggestions may bring aid and comfort to the man who wishes to get some practical benefit out of the subject. In the first case he should know that while it is a difficult matter to become an expert in all branches of thermodynamics, it requires only a reasonable amount of brains and application to learn a few simple facts that will carry him a long way. He should, therefore, avoid those books whose pages have the appearance of a Greek dictionary and seek for a "primer" of the subject. The word "thermodynamics" may not occur in the title, but the book must tell about heat and work and their relations. A suitable "primer" will tell in simple language what a B.t.u. is, what is its equivalent in foot-pounds and similar elementary facts and principles. The best book for the average operating engineer will have pictures of the boilers, engines and other apparatus with which he is familiar. It will "tie in" at every possible point with the things he already knows and it will contain many practical numerical problems, some worked out and some left for him to solve.

The only practical way for the average man to get any real knowledge of thermodynamics is to go slowly and drive each principle home so thoroughly that it will never be forgotten. It is most important for him to get a set of standard steam tables and by constant drill learn to use them just as he once learned to handle a file or a Stillson wrench; that is, by constantly using them to accomplish actual practical results. It will pay any engineer to master the simple uses of these tables so that no one can trip him up when it comes to figuring the amount of heat in steam at any pressure and condition of dryness or superheat.

Fortunately, the easiest things in thermodynamics, as in many other sciences, are the most useful. So let the engineer ground himself solidly in the following and he will have made real progress: Law that energy can neither be created nor destroyed; meaning of B.t.u.; meaning of foot-pound; meaning of horsepower; factors for changing work into heat and vice versa; use of steam tables to get heat in water or steam under any conditions; various meanings of "efficiency."

These are the tools. When a man has them all sharpened and has thoroughly drilled himself in their handling, he will find an almost limitless field for their practical use.

A Praiseworthy Effort To Help Inventors

THE road of the poor and obscure inventor is proverbially a rocky one, although the progress of civilization and its present state of advancement is largely the result of his efforts. The life story of practically every great man reveals early struggles against all kinds of troubles and obstacles, but it is generally considered that an inventor has a peculiarly difficult and fruitless existence up to the time when he achieves success; and too often before that times comes he has lost heart or has been robbed of his invention by clever and conscienceless promoters. This situation has long and justly been regarded as a serious barrier in the way of industrial progress.

To eliminate this unfortunate condition there has recently been formed an association of inventors, engineers, scientists and financiers, which will aim to act as the missing link, or universal interpreter, between the inventor, the business man and the banker. The president of this organization is Dr. Miller Reese Hutchison, who was formerly Thomas A. Edison's chief engineer, and is himself an inventor of note. Some of the directors are Hudson Maxim, Rear Admiral Samuel McGowan (retired Pay-Master General of the United States Navy), and Edgar Rees Jones, M. P., who was at the head of the Priorities Division of the British Ministry of Munitions during the War. Mr. Jones will act as European Director of the association.

It is expected that the association will give the inventor protection in the development of his ideas, and in certain cases financial help during the period of his experiment. This protection is to continue during the securing of his patent and the manufacture of his product. The business man, on the other hand, will also be protected, because every invention will be thoroughly judged and tested by a group of experts in the various specialties embraced. The invention must first receive the indorsement of an engineer in good standing and must then be passed upon favorably by the Technical Staff and submitted to outside experts for report on the possible commercial demand, the integrity of the theories embraced, its patentability and the validity of the title. Before any mechanical work is done on the device, it will be thoroughly designed and complete drawings made. A model will be made and tested to destruction to uncover without delay those weaknesses that might not be disclosed by ordinary usage for months.

The association has a splendid object, its opportunity is tremendous, and it will have the backing of everyone that wants to see the world advance. If it succeeds, it will have rendered a service of the highest order.

The Necessity of More Research Work

THE chief reason for the dominant position held by Germany in the past in a number of industries was the great amount of research work carried on. Those who are at all in touch with European developments, are aware of the millions spent in laboratory work—in striking contrast to the slender resources and facilities open to the American research worker. In this country the need for such technical investigations has not in the past been so apparent, since many leading manufacturers were content to procure licenses to manufacture after European designs or formulas.

The license system is no longer advisable, for America is now a strong competitor for the world's trade. It behooves us to lay more extensive plans for American research work.

There are already many firms who are carrying on work of this nature in a limited way. Unfortunately, there is the well-nigh universal feeling that the results secured are trade or firm secrets which should be withheld from publicity. Professor Green, chairman of the Research Council of the American Society of Mechanical Engineers, in a statement recently issued lays considerable stress on the advantages of a more frequent and open exchange of data by engineers. As he states, many data are buried where they are doing no work and their publication would not damage one's business and would help the profession. Even if only the unfavorable tests were reported, other engineers would be saved much unprofitable investigation.

English engineering societies have been fortunate enough to secure a considerable amount of data on the internal-combustion engine. The publication of this material, especially the Admiralty tests, has contributed much toward the engineer's information on the oil engine. While the Bureau of Mines in this country has done considerable work along this line, lack of available funds prevents a deep investigation. Many firms are conducting tests and research work, especially on the solid-injection engine. If by the work of one central research laboratory the endless duplication of effort were avoided, more progress could be recorded at an immeasurably lower cost.

Dr. Green points out that the question of the most efficient steam pressure and superheat for large central stations is by no means solved. This is a field where research work would give a large immediate return, for a uniform practice is by no means followed in plants of like size. Undoubtedly, in some plants either the first cost has been too high in the attempt to carry high pressures or in others the efficiency of operation has been lowered by too low pressures.

One field of research which offers particularly great inducements would be the investigation of lubricating oils and lubrication in general. No other phase has had as much written concerning it with less research foundation. Lubrication engineering has suffered from the tendency of those acquainted with the inside facts to withhold this information from the public. This has resulted in unsuitable oils being put in use in power plants to the injury of the machinery and to the detriment of the intelligent marketer of lubricating oils.

That engineers are awakening to the advantages of research work is proved by the action of a large hydroelectric company in proffering all its facilities for an extended hydraulic research.

CORRESPONDENCE

Pulverized Coal Weighed

In an editorial in the May 31 issue entitled "Some Facts Concerning Pulverized Coal," commenting on tests at the Oneida Street plant of the Milwaukee Electric Railway and Light Co., the statement is made that this was the first series of tests in which the powdered coal was actually weighed. This is not strictly correct because several previous tests were made with powdered coal on boilers where the coal was weighed. One of these tests was made on a vertical Rust water-tube boiler at the Allentown Portland Cement Co., early in June, 1920.

The boiler was twelve years old when the test was made and was not a very efficient type, having only one vertical baffle, and the baffling was not in very good condition. Nevertheless, the combined boiler and furnace efficiency was 77.3 per cent, at a little over boiler rating (111.2 per cent), with the flue-gas temperature at 621 deg. The coal was weighed on platform scales at the boiler and the water was also measured, the test being run practically according to the A. S. M. E. Code.

New York City. FREDERICK A. SCHEFFLER.

Return-Tubular Boilers, Tubes and Setting

I have been much interested in some of the articles published in recent issues of *Power* regarding tubes in fire-tube boilers. I consider the size of tube of small importance, but clean tubes are of importance, and as the heating surface of all fire-tube boiler shells is comparatively small, the tubes should be kept clean. I believe 60 per cent of boilers of this type are wasting fuel because the tubes are not kept clean. Regardless of what kind of tube blower is used, in time the tubes will incrust and will need a scraper put through them. If anyone doubts this statement, let him use a blower for, say, three months and then put through a good tube scraper that fits the tube, and see what happens.

I have been in several plants where the firemen seem to think that the more coal they can pile on the dead plate the more steam they will make; consequently, the dead plate burns out, doors warp, heat is lost and the efficiency falls off.

I take a contrary view to one recently expressed in *Power* on setting return-tubular boilers. I would not take a boiler of this design, where bituminous coal is used, unless it was hung at least 36 in. from the grates and would prefer it to be 45 in. Low setting is one reason for so much smoke, as the gases strike the bottom of the boiler and pass to the rear end of the setting where they enter the tube and all combustion ceases.

I am also of the opinion that with the higher boiler setting the gases will readily pass through all the tubes.

I do not believe that there is positive circulation in the return-tubular boiler. If some boiler expert will tell me why the water in such a boiler flows up the center and down the sides, I shall be pleased to hear from him through *Power*. I believe it does no such thing, but that the tendency is to rise up the sides, then flow down the center of the boiler between the tube spaces, because the sides of the boiler are exposed to the furnace heat and the heavy body of water is over the fire. When we get a positive circulation through a return-tubular boiler, we will have a fast-steaming boiler, whether the water goes from the back end to the front or the other way. Of course, the fire tube would not have the heating surface as though the water were inside the tubes and the fire outside, but the same idea would be embodied.

I believe a large volume of water under a rapid circulation is better than a small body of water, for the reason that it will hold up better when cleaning fires than where a small body of water in the tubes is exposed to the cooling air when cleaning.

Gloversville, N. Y. Q. W. GILLETTE.

Preventing Scale in Condensers

The writer notes in your issue of June 21, 1921, page 1027, inquiry asking how to prevent the deposit of sediment in condenser. The answer given is to supply air under pressure into the water line to the condenser. Without knowing the details of the condenser or the actual troubles of your correspondent, I cannot entirely agree with the advice given; in fact, I very much doubt whether this will cure the trouble.

The writer's advice would be that in case the water carries much sediment that causes trouble, the only way to overcome the difficulty is to refrain from using the water entirely and instead use a water-cooling tower with the makeup obtained from a different source or with a makeup in which the sediment can be readily removed, as the quantity of makeup is only about 1 per cent of the total amount of water circulated, provided the work is done in a cooling tower that has been properly designed. E. BURHORN.

New York City.

[Air agitation is used in several plants, and has been quite successful in one of the largest refrigerating plants in this country.—Editor.]

Change in Controller Connections Improves Operation

A three-phase 15-hp. variable-speed induction motor running a large machine is equipped with a motor-operated brake, similar to an elevator brake except that it is operated by a small motor instead of a solenoid. The operation of the brake is as follows: The brake-motor leads are connected across the leads

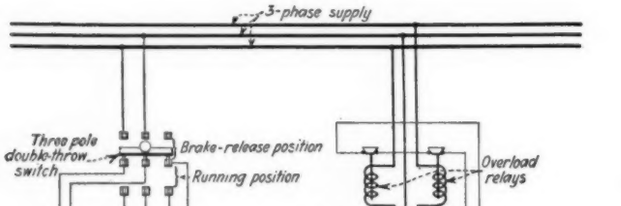


DIAGRAM OF CONNECTIONS TO DRIVING MOTOR, BRAKE MOTOR, AND CONTROLLER

The triple-pole double-throw switch was added to release the brake when the driving motor is disconnected. Note that the secondary connections in the controller are not shown.

of the driving motor, as shown in the diagram, and the brake band bears on a small pulley keyed to the main driveshaft. The brake is applied by a heavy spring, so that the duty of the brake motor is to release and not apply the brake. When power is applied to the driving motor, the brake motor starts up and makes three or four revolutions. It is geared to the brake in such a way as to release it and then lock itself, so that it can turn no farther. As long as the driving motor is running, power will be on the brake motor and will keep the brake released; but as soon as power is shut off, the brake-motor lock is released and the brake is applied by the spring.

The brake worked well, but it was unhandy when it was desired to turn the machine by hand. The tension on the brake spring had to be unscrewed, and care had to be taken to put the spring back under the same tension before starting up again. This was very slow, so it was decided to do it electrically.

The 15-hp. motor is controlled by a magnetic contactor switch operated by contact *B* in the controller, which opens and closes the circuit of the contactor-switch closing coil. The three-pole double-throw switch was added, as shown, so that when it is in the lower position, everything is operating normally. When the machine is not running and it is desired to turn it by hand, the switch is thrown to the upper position. This starts the brake motor and releases the brake. One of the closing-coil leads is run to one pole of the switch so that the motor cannot be started when the brake is held open. With this arrangement the machine will be shut down if anyone accidentally opens the switch while it is running. The contact *A* was added to the controller, as the contact *B* only closes the circuit of the closing coil on the first point of the controller. After the first point is passed, the closing circuit is through the contact *A* and the reset contact, the latter being closed when the magnetic switch is closed. With this arrangement, if the power fails or the motor is shut down for any reason, it cannot be started again until the controller is returned to the first point, which is a desirable feature. These connections have saved considerable time and have proved very satisfactory.

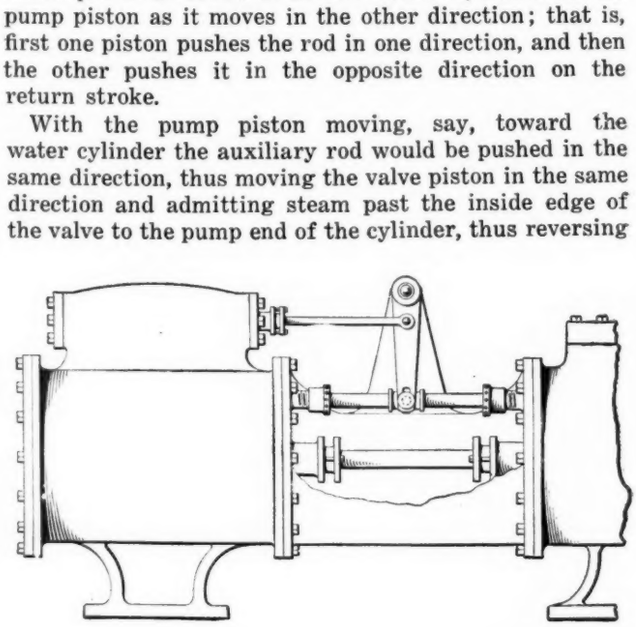
Kaukauna, Wis. MARIN PHILLIPS.

Peculiar Design of Simplex Pump

During a recent visit to the plant of the Tide Water Oil Co., at Bayonne, N. J., among numerous other interesting things seen was a simplex pump that was used to pump liquid wax. It is an old-timer, and no one about the plant knows who made it, but it is said to be about 35 years old. In design it differs materially from the general run of simplex pumps.

The steam and pump pistons and rod are of ordinary design. The steam valve is of the piston type, steam being admitted at the inside edges of the valve. Motion is given to the valve by a valve rod and rocker arm, the latter being moved back and forth by a secondary rod. This rod is fitted with a spool central of its length, and it passes through a stuffing box fitted to each cylinder and above and to one side of the main piston rod. This secondary rod extends through the stuffing boxes a distance sufficient to come in contact with the steam piston as it moves in one direction, and with the pump piston as it moves in the other direction; that is, first one piston pushes the rod in one direction, and then the other pushes it in the opposite direction on the return stroke.

With the pump piston moving, say, toward the water cylinder the auxiliary rod would be pushed in the same direction, thus moving the valve piston in the same direction and admitting steam past the inside edge of the valve to the pump end of the cylinder, thus reversing



PUMP WITH PECULIAR VALVE MOVEMENT

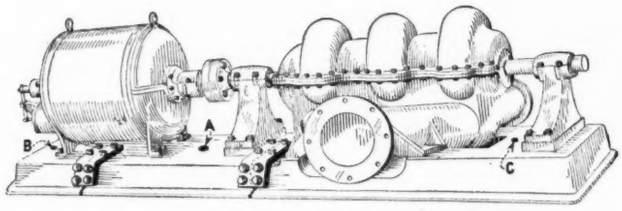
its stroke. The pump piston on its return stroke would push the auxiliary rod toward the steam cylinder and move the piston valve to admit steam to the head end of the steam cylinder. The length of the auxiliary rod is such that the piston travels the greater portion of its stroke before coming in contact with it to move the piston valve.

Perhaps some reader may be familiar with this design of pump. From certain characteristics it is possible that it was one of the early Marsh design.

Jersey City, N. J. O. W. MILLER.

Cracks in Pump Bedplate Due to Inadequate Grouting

The necessity for filling the bedplates of high-speed power-plant machines with grout, so as to make solid contact between the machine and the foundation throughout the entire base area, was exemplified recently by the breaking of an inadequately grouted bedplate under a high-speed pumping unit. The unit consists of a multistage centrifugal pump driven by direct shaft connection from a steam turbine running



CRACKS WERE PATCHED AND THE BED REGROUTED

at 1,900 r.p.m. Both machines are mounted on the same baseplate, as shown in the sketch, making a supposedly rigid base.

For some time the inboard bearing of the pump had been running hot—so much so as to necessitate cooling with a stream of water from a hose. The cause of the heating remained a mystery until the engineer accidentally discovered that it was due to a double fracture in the bedplate. The latter had been so thickly coated with coal dust and grease as to obscure the cracks in the metal.

While starting the pump one morning, the engineer casually rested his foot on the edge of the bedplate at a point directly beneath the turbine and was immediately aware of a slight weaving motion at that point. When the plate had been cleaned, two fractures were revealed. One of these was beneath the turbine, and the other was between the turbine and the pump. As both fractures extended straight across, they had caused a slight sagging of the bedplate between the two machines, thus throwing the bearings out of alignment, hence the heating of the inboard pump bearing.

The damage was repaired by bridging each crack with an iron strap ½ in. thick and 4 in. wide as shown. The ends of the straps were turned down to a close fit with the tapered sides of the bedplate. Each strap was secured by two rows of ½-in. capscrews spaced 4 in. apart.

A 2-in. hole was drilled at the center of the bedplate, as indicated at *A*. Also two 1-in. holes were drilled close to each end of the plate at *B* and *C*. A thin grout of portland cement was then poured into the base, through the 2-in. hole, until the cavity was filled. This was manifested by the grout exuding through the 1-in. ventilating holes at *B* and *C*. The job was allowed to stand for two days to permit the grout to harden thoroughly. The foundation bolts were then tightened down securely, and the pump was put in service. No further trouble was experienced with the inboard pump bearing and this method of making the repair proved satisfactory.

A. J. DIXON.

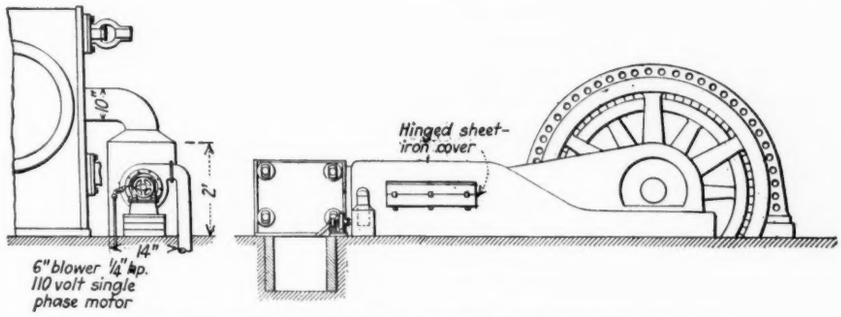
St. Louis, Mo.

Eliminating Oil Vapor from Corliss Engine

In a large industrial power house there was considerable trouble from oil vapor condensing on the windings of a 3,000-kw. alternator driven by a Corliss engine. In a unit of this size the powerful fan action of the large-diameter field rotor draws in the air surrounding the engine and forces it through the winding. Since oil is deleterious to the varnish of a winding, means were taken to eliminate all the vaporized oil from around the engine that was possible. Practically all the vapor was found to come from inside the crosshead-guide casing, the oil being vaporized on the hot piston rod and mixing with the vapor escaping from the packing gland and from the hot metal of the cylinder head. Thus vapor was expelled from the casing with each stroke of the crosshead, resulting in a considerable volume during a day's run.

The opening in the side of the crosshead guide was fitted with a folding sheet-iron door, hinged at the bottom and leaving a narrow slit at the top for the telescoping crosshead oiler. We had a 6-in. blower available, driven by a ¼-hp. 110-volt motor. The blower was set on a wooden frame outside the cylinder on the generator side of the engine, and a 10-in. galvanized pipe elbow was set in the hole of the frame opposite the packing gland. This elbow led into a receiver about 14 in. in diameter and 2 ft. high; a pipe was soldered in the side of this receiver and led to the suction of the blower. The exhaust of the blower turned down to a grating in the floor over a tunnel. The receiver was fitted with a drain, and we are reclaiming over a quart of oil a day from the vapor that is being sucked from the crosshead casing.

Most of this oil formerly went into the winding of the generator, since a solid wall prevents the movement of the air except toward the generator. The vapor from the vicinity of the opposite cylinder is able to escape through windows on that side; consequently, we are able to maintain the windings dry and without fear of the rapid deterioration of the insulation of the 2,200-volt coils, a condition that every operator desires to maintain.



FAN FOR REMOVING OIL VAPOR FROM ENGINE FRAME

The rewinding cost of such a generator would be about seven thousand dollars, while the cost of the blower was $100, and the cost of installation was $75. The pipe and receiver were built in the plant's sheet-metal shop out of galvanized sheet iron. The saving is well worth while considering the possible interruption to production as well as the large rewind cost involved when making repairs.

J. ELMER HOUSLEY.

St. Louis, Mo.

High-Head Centrifugal Pump

Our attention has been called to an article recently published in *Power* relative to an exceptionally high head centrifugal pump at the water works at Shenandoah, Pa., which has a capacity of 2,000,000 gal. a day against a total head of 1,000 ft., with an efficiency of 62 per cent.

We have in operation a pump at the Colonial Salt Co., Akron, Ohio, which has a capacity of 800 gal. per min. against a total head of 1,150 ft. and has an efficiency of 72 per cent. We are at the present time also building two pumps for the Eastern Potash Corporation, New Brunswick, N. J., which have a capacity of 1,000 gal. per min., 1,386 ft. total head, operating at 1,200 r.p.m. with a guaranteed efficiency of 68 per cent, which we hope to better. These are both eight-stage centrifugal pumps.

W. S. HORNER,
Manistee, Mich. Manistee Iron Works Co.

Boilermakers as Inspectors

The article on "Boilermakers as Inspectors" on page 714 of the May 3 issue is interesting, but it is apparent that the writer is not considering the question from the boilermaker's viewpoint. It is true, the art of boilermaking has not been rated as a science, for a great deal of the practice of that trade is traditional and has never been classified in such a way as to be considered scientific, but the younger generation of boilermakers have found that a study of triangulation is necessary in order to develop properly many of the patterns used in sheet-metal work, and to them the few calculations necessary to determine the safe working pressure of a boiler are easily understandable.

The difference of opinion as to whether the engineer or the boilermaker develops into a better inspector, is not a new one, and while the engineer may contend that there would be fewer explosions were boilers properly built, the boilermaker may respond that there would be fewer explosions were the boiler properly operated; and there is no doubt that a proper knowledge of boiler-shop practice, as well as boiler-room operation, is essential to the successful boiler inspector.

Frequently, the engineer points out the fact that in a certain location a boiler inspector must have had a certain number of years of engine-room experience, while the boilermaker may refer to the legal requirements of some other location, where boilermakers are employed as inspectors only after having had five or ten years' boiler-shop experience. The legal requirements, so far as qualifications for boiler inspectors are concerned, are not conclusive, but rather indicate whether the boilermakers or engineers were the best politicians.

There are a great number of inspectors who have followed the boiler-making trade, just as there are a great number of successful inspectors who received their primary training in an engine room. The fact that a man may have been engaged in either place does not give him all the qualifications necessary to become a successful inspector; neither does a short course of study in arithmetic, nor an acquaintance with the slide rule. There are many capable engineers who would never develop into boiler inspectors, and likewise there are many good boilermakers who lack the training and judgment so necessary in boiler inspection, so that at best the time spent in the boiler shop or in the engine room should be looked upon only as affording an opportunity for preliminary training or as establishing a foundation on which a knowledge of boiler-inspection work can be based. The structure that can be reared on that foundation depends more on the ability of the individual than on whether he spent his early years in an engine room or a boiler shop.

With the inspectors who have had engine-room experience, there is a tendency to "keep the plant in operation" by making temporary repairs that are sometimes questionable, while the inspector who has spent his early years in the boiler shop is more impressed with the idea of shutting down immediately for repairs, even when the continuation of the boiler in operation may not be dangerous. Many individuals, whether they be engaged in boiler inspection or in other work, do not possess the ability to discover and properly weigh all the conditions bearing on a subject, so one man may underestimate while another man may overestimate the importance of conditions that are not just as they should be.

Just because a boilermaker goes into a plant to repair a boiler and encounters an engineer who has no idea of what or how the repairs should be made, and the condition of the plant shows a general lack of engineering knowledge, would not be sufficient reason on which to base a statement that engineers have no boiler knowledge, and likewise, all boilermakers should not be condemned as unfit to be inspectors just because one following that trade lacked good judgment.

Chicago, Ill. M. P. JOHNSON.

Proposed Code for Welded Pressure Vessels

The matter of a code for welding pressure vessels by the oxyacetylene process has been under discussion for several years, but it is only recently that real progress has been made in the solution of the problems involved. I have felt that it might be possible to help the work along by putting something definite on paper, the idea being that an opportunity will be given for criticism. I realize that the proposed code is neither complete nor perfect, but it embodies the results of my personal experience, and I believe it to be fundamentally correct. The ideas on which it is based are as follows:

First, the making of welded pressure vessels, so that the plate will always be weaker than the weld, even if the latter be somewhat defective. We must realize that we cannot expect, in production work, absolute perfection.

Second, that soft low-carbon plate, which is ductile, will stand welding strains better than higher-carbon material. In fact, the strains which are concentrated in the weld in higher-carbon material are distributed through the low-carbon material by stretching it beyond its elastic limit, which does not occur in the higher-carbon material with higher tensile strength.

Third, a considerable margin should be maintained between the strength of the weld and the strength of the plate, in order to obtain the desired results. In a weld made in high tensile-strength material the nickel-steel wire specified will give a strength of from 56,000 to 58,000 lb. per sq.in., so that with 50,000-lb. plate a weld made with it will have a strength greater than that of the plate, of about 15 per cent, without allowing for any reinforcement of the weld, which will add to

its strength. It may also be of interest to know that under combined alternating stress and shock pieces made in this way always break outside the weld.

The use of this low-carbon plate is not new. In fact it has been used for a number of years. Neither is the use of nickel-steel welding wire new, but I think that the idea of deliberately making the plate weaker than the weld is brought forward for the first time.

Proposed Code for Unfired Pressure Vessels

Classification—Class A vessels are those carrying over 15 lb. pressure per square inch (for containing liquids at temperatures above their boiling point at atmospheric pressure, inflammable substances, or any gas), which are over 6 in. in diameter and more than 1.5 cu.ft. in volume. Class B vessels are those carrying over 30 lb. pressure per square inch but not exceeding 100 lb. pressure per square inch (for containing liquids at temperatures that are under control so as to be below their boiling points at atmospheric pressure) which are over 9 in. in diameter and more than 4 cu.ft. in volume. The rules for Class A vessels apply to Class B vessels carrying over 100 lb. pressure per square inch.

Material—These rules apply only to vessels made of steel plate or sheet, welded by the oxyacetylene process.

Physical and Chemical Properties of Plates—All plate or sheet steel used for either Class A or Class B vessels shall have the following characteristics: Physical—Tensile strength, 50,000 lb. per sq.in. maximum; yield point, at least $\frac{TS}{2}$; minimum per cent elongation in 8 in., $\frac{1{,}500{,}000}{TS}$. Chemical—Carbon, per cent, 0.12 maximum; manganese, per cent, 0.35 to 0.50; phosphorus, per cent, 0.04 maximum; sulphur, per cent, 0.04 maximum. It shall be made by the open-hearth process. Each plate ¼ in. thick or over shall be marked according to the American Society for Testing Materials Specifications for 1918, page 257, section VI.

Tests for Welding Quality—It shall be of good welding quality.

Formulas for Design—The working pressure of unfired pressure vessels shall be determined by the following formulas:

For Class A, $p = \frac{2tT}{5D}$

For Class B, $p = \frac{2tT}{4D}$

in which p = working pressure, t = actual thickness of material, T = tensile strength of plate used, in pounds per square inch, D = the inside diameter of the shell.

Welding Used as Calking for Riveted Joints—In such cases no allowance shall be made for the strength of the weld, and all calculations shall be based on the formulas for riveted joints as designated in the Boiler Code.

Maximum Thickness—No vessel shall be made of plate over ⅝-in. in thickness.

Ratio of Diameter to Thickness—In Class A vessels the ratio of diameter to thickness shall in no case exceed 120, both dimensions being measured in the same units, unless the shell is corrugated or otherwise so made as to avoid flattening.

Ratio of Length to Diameter—No Class A vessel shall have a greater ratio of length to diameter than 5, unless it be 36 in. or more in diameter. Class B vessels may be of any length provided the inside of the seam can be properly inspected.

Existing Vessels—Existing Class A vessels, not made according to this code, shall be allowed a working pressure according to the formula $p = \frac{2tT}{10D}$. Existing Class B vessels, not made according to this code, shall be allowed a working pressure according to the formula $p = \frac{2tT}{8D}$ the symbols having the meanings as given.

Welding Wire—The welding wire shall be of the following composition: Carbon, 0.18 to 0.22 per cent; manganese, 0.40 to 0.50; phosphorous, 0.04 to maximum; sulphur, 0.04 maximum; nickel, 0.3 to 0.3½. It shall be clean and flow freely during welding, without showing undesirable properties. When melted with torch tip of the size shown in the table, it shall not "spit" or throw out sparks. It shall make a smooth head, free from roughness, irregularities and porosity.

Wire ⅛ in. diameter, No. 3; diameter mixing chamber, in. 0.0465.

Wire 5/32 in. diameter, No. 4; diameter mixing chamber in. 0.055.

Wire ¼ in. diameter, No. 5; diameter mixing chamber, in. 0.067.

SIZE TIP

Thickness of Steel, In.	Davis-Bournonville Tip No. Pre-heated	Davis-Bournonville Tip No. Not Pre-heated	Approximate Size of Mixing Chamber Drill Size, Tip No.	Approximate Size of Mixing Chamber Diam., In.	Area of Mix. Chamber Tip No.	Area of Mix. Chamber Sq.In.	Approx. Acetylene Consumption per Hr. in Cu.Ft.
1/16	4	4	4-54	0.055	4-0	0.002376	10
1/8	4	5	5-51	0.067	5-0	0.003526	15
5/32	5	5	5-51	0.067	5-0	0.003526	15
3/16	5	6	6-48	0.076	6-0	0.004536	20
7/32	6	6	6-48	0.076	6-0	0.004536	20
1/4	6	7	7-44	0.086	7-0	0.005809	25
9/32	7	8	8-39	0.0995	8-0	0.007775	35
5/16	7	8	8-39	0.0995	8-0	0.007775	35

The acetylene consumption is obtained by multiplying the area in square inches of the mixing chamber by 4,000. It is essential that no larger tip be used than necessary to obtain thorough fusion.

Size Wire—Use diameter ⅛ in. for less than 3/16-in. plate; 5/32 in. for ¼-in. and 7/16-in. plate; 3/16 in. for ⅜-in. and 7/16-in. plate; ¼ in. for ½-in. and over.

Method of Welding—Longitudinal seams on Class A vessels shall be welded on both sides and the inside shall be welded first. The scale formed on the outside by this welding shall be carefully removed from the V and around its edges, before making the outside weld. Such seams shall be preheated to, and kept at, a red heat while being welded. Longitudinal seams on Class B vessels may be welded from one side (the outside) only, but the weld must penetrate the entire thickness of the sheet, and the bottom edges of the V must be thoroughly fused to each other.

Circumferential seams of both Class A and Class B vessels may be welded from the outside only. For Class A vessels they shall be preheated to and while welding kept at a red heat, at all points except where the welding is being done.

Rerolling—The shells of all Class A vessels shall be rerolled after welding to insure their roundness.

Thickness of Weld—The longitudinal seams in Class A vessels shall be reinforced by at least 15 per cent of the plate thickness on each side, and one-half of this shall be removed by grinding after examination with the magnifying glass and before the hydrostatic test. Longitudinal seams in Class B vessels shall not be reinforced more than 10 per cent of the plate thickness and need not be ground.

Thickness—After rerolling Class A shells, the scale shall be removed from the weld, and a careful examina-

tion with a magnifying glass of at least three powers shall be made of each longitudinal weld and adjacent material outside and inside, to detect cracks or other defects, which shall be repaired, if practicable, by rewelding. If the defects are not removed or if others appear anywhere in the vessel, due to the welding, the vessel shall be rejected. Only one rewelding shall be allowed. The entire seam shall be preheated in the specified way before rewelding the defects, which shall be done from both sides, the inside first, after which it shall be rerolled and the entire seam again examined.

In Class B vessels all scale shall be thoroughly removed from the inside of the weld and adjacent surfaces before examination, and if any unfused spots over ½ in. long are found or if the total unwelded spots amount to over 10 per cent of the total length of the weld, such spots shall be rewelded, the entire seam being preheated to a red heat before welding.

Class A vessels shall be tested after completion, to a hydrostatic pressure twice the working pressure, and while the full test pressure is on the vessel, the seams shall be struck every foot with one blow of a sledge. The weight of the sledge shall be 4 lb. for ¼ to ⅜-in. sheets; 5 lb. for over ⅜ to ½-in.; 8 lb. for over ½ to ⅝-in., and 10 lb. for ⅝-in. Good swinging blows shall be used, and a flatter straddling the weld shall be used to prevent injury to the work. Class B vessels shall be tested in the same manner as Class A, except that the test pressure shall be 1½ times the working pressure.

Annealing—All seams in Class A vessels shall be annealed at a dull-red heat to relieve shrinkage strains. The preheating referred to under preheating paragraph shall be considered the equivalent of annealing, provided that after welding the whole seat is brought to an even temperature, not less than a dull red. Seams in Class B vessels need not be annealed.

I have no doubt that criticism will be made of a number of the precautions specified, but I feel that for safety and in view of the lack of complete knowledge, which will later be obtained, we should use these precautions until further experience shows them to be unnecessary.

As the purpose of the proposed code is to invite criticism, I hope there will be plenty of it.

Rochester, N. Y. S. W. MILLER.

New Unaflow Engine Design

Referring to the article on the unaflow engine design, page 1042, of the June 28 issue, one of our friends has called attention to the paragraph on page 1043 under "Reducing Clearance Losses," as follows:

Present types of unaflow engines with clearance volumes of from 3 to 5 per cent are therefore less efficient, owing to the greater pressure range and insufficient compression. For every 1 per cent in clearance volume there will be a corresponding increase in steam consumption, amounting to 0.44 lb. with saturated steam and 0.83 lb. with superheated steam per horsepower-hour.

Perhaps it should be made clear that this refers to high-pressure or condensing engines rather than to those operating noncondensing or with back pressure, and the statements should be read in the light of the general declaration at the beginning of the main paragraph. I have grouped high-pressure and condensing engines together, because in general they both work through a higher range of pressures and temperatures than a non-condensing engine working at ordinary boiler pressures. In other words, both condensing engines and high-pressure non-condensing engines naturally require small clearance volumes. Of course, high-pressure condensing engines require smaller clearances than any others. There are, therefore, three classes for which Prof. Stumpf has brought out this new design.

Auxiliary exhaust valves in unaflow engines cause losses due to part of the cold exhaust steam flowing back along the hot cylinder, and also due to the extra clearance pocket around the valve, and we can assume that these losses will increase with the range of temperature for changes in back pressure and initial pressure. The clearance losses are variable with change in range of pressures, and therefore the curves that might be drawn to represent these losses would cross at some point. We believe that for atmospheric exhaust this point would be at about 130 lb. steam pressure, with not over 50 deg. superheat. William Clinton Brown writes on this subject as follows:

I have not seen the article referred to, but I understand it was sent to *Power* by Professor Stumpf and probably refers to a new valve motion which he is bringing out to reduce the clearance of condensing engines, because we cannot compress up to the initial steam pressure with the clearance of our present condensing engines. The practice in Germany is almost entirely condensing engines, so Professor Stumpf has given little consideration to non-condensing engines.

Clearance in non-condensing engines causes a loss that increases as the back pressure increases and as the steam pressure decreases, as the clearance has to be increased in both cases. Auxiliary exhaust valves cause a loss due to part of the steam flowing back and the pocket in the cylinder, and let us assume that this loss is practically constant, so that in one case we have a constant loss and in the other case a variable loss. Where these losses cross I am not prepared to say, but at atmospheric exhaust I believe it to be about 130 lb. steam pressure.

I can imagine a case of 15 or 20 lb. back pressure above atmosphere and low steam pressure, when the auxiliary exhaust valves would show a saving as great as 23½ per cent, but on the other hand all our records point to the fact that with 150 lb. steam pressure and atmospheric exhaust the straight unaflow has a little the advantage.

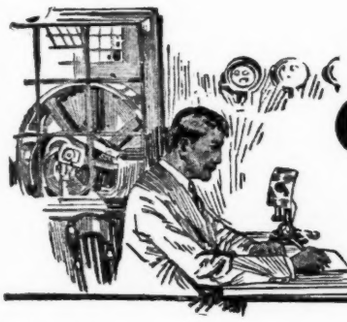
It should be recognized more widely than it is that where the unaflow engines gain most in economy is with the increasing range of temperatures. Professor Stumpf's new design is especially adapted to the high-pressure condensing service, which has long been in use in Europe and which is becoming more and more used in United States and elsewhere.

Professor Stumpf is doing some interesting research in the effort to adapt the simple two-valve unaflow engine for non-condensing and back-pressure service, and it is hoped that he will publish articles regarding this in the near future. C. C. TRUMP, Vice President,

Syracuse, N. Y. Stumpf Una-Flow Engine Co., Inc.

[The article in question is an abstract of advance proofs of Professor Stumpf's revision of his book on the Una-Flow engine, courteously furnished to *Power* by the author.—Editor.]

Grate Surface means the area of the grate upon which the fire rests. It is usually expressed in square feet. A grate 6 ft. wide and 7 ft. deep has a grate surface $6 \times 7 = 42$ sq. ft. The air openings in the grate, through which the air passes from the ashpit into the fire, should be from 30 per cent to 50 per cent of the total grate surface. The amount of grate surface for a boiler of a certain size depends on the kind of fuel to be burned and on the force of the draft available.



INQUIRIES OF GENERAL INTEREST

Surging of Water in Boiler Gage Glass—What causes continual rising and falling of water level in a boiler gage glass? R. G. N.

Surging of glass-gage water level usually is due to alternate banking up and falling of water level in the boiler over the point where the water column is connected to the water space of the boiler, due to oscillation of the whole body of water, induced by circulation of the water, or boiling. Or surging in the glass gage may be due to variations of pressure in the steam connection of the water column, caused by drafts of steam taken out of the boiler near the point where the steam connection is made for the water column.

Safe Working Pressure for Dished Heads—What is the formula for determining the safe working pressure for unstayed bumped head with the pressure on the concave side, and also for pressure on the convex side? M. J. B.

The formula for thickness required in an unstayed dished head with the pressure on the concave side, when it is a segment of a sphere, is given by the A. S. M. E. Boiler Code,

$$t = \frac{5.5 \times P \times L}{2 \times TS} + \tfrac{1}{8}$$

where

t = Thickness of plate, in.;
P = Maximum allowable working pressure lb. per sq.in.;
TS = Tensile strength, lb. per sq.in.;
L = Radius to which the head is dished, in.

Where two radii are used the longer is to be taken as the value for L, and in no case is L to be taken as less than 80 per cent of the diameter of the head. By transposing the formula, the maximum allowable working pressure is found to be

$$P = \frac{(t - \tfrac{1}{8}) \times 2\,TS}{5.5 \times L}$$

When the dished head has a manhole opening, the formula is to be taken as

$$P = \frac{(t - \tfrac{1}{4}) \times 2\,TS}{5.5 \times L}$$

and the manhole opening is to be flanged to a depth measured from the outside of not less than three times the thickness of the head. It is also understood that the foregoing formulas shall apply only to cases where the corner radius measured on the concave side of the head is less than 1½ in. or more than 4 in., and between these limits not less than 3 per cent of the value used for L in the formula.

When the pressure is on the convex side, the maximum allowable working pressure is 60 per cent of that for heads of the same dimensions with the pressure on the concave side.

Testing Armatures with Direct Current—How can direct-current armatures be tested for short-circuited or open-circuited coils, using direct current only, and what instruments are necessary for such tests? H. P. C.

In testing direct-current armatures for open- or short-circuits, the best method is to connect the armature in series with a resistance across the direct-current line and adjust the resistance to give a current through the windings of somewhat less than rated full-load current. Then measure the drop between adjacent commutator bars all around the armature by means of a millivoltmeter. Any drop considerably below the average will indicate a short-circuit, either between the coil leads or the bars. Any drop considerably above the average will indicate an open-circuit. If a millivoltmeter is not available, it may be replaced by an ordinary telephone receiver with satisfactory results. With current flowing through the armature as in the foregoing test, touch the receiver leads to adjacent bars all around the armature. As the circuit of the receiver is closed, a very noticeable click should be heard. No click will indicate a short-circuited coil, while an exceptionally loud click will indicate an open circuit.

Pound in Diesel Engine—In our Diesel engine one cylinder pounds when the piston is at the upper dead center at the end of the exhaust stroke. What is the cause? L. G.

Without more definite information as to make, etc., of the engine two possible causes can be outlined. If the crankpin bearing is slack, then as the piston moves upward on the exhaust stroke and the crank turns and starts downward, the inertia of the upward moving piston causes the piston rod and crank bearing to strive to continue moving upward. As a result the lower part of the crankpin bearing strikes against the crankpin, causing a pound. On the compression stroke the air pressure within the cylinder overcomes the piston inertia and the upper half of the bearing is held snugly against the crankpin as the piston reverses its travel.

A second cause may be the striking of the piston against the cylinder head due to a slack crankpin bearing. This, however, is possible only in those engines where the clearance between head and piston is very small. In either case by decreasing the crankpin clearance, the pound should disappear.

Required Size of Safety Valve for Boiler—What size pop safety valve should be supplied for a water-tube boiler having 400 sq.ft. of heating surface; to be operated at the pressure of 150 lb. gage? E. R. M.

According to paragraph 274 of the A. S. M. E. Boiler Code, the total relieving capacity of the safety valve or valves required on a water-tube boiler shall be determined on the basis of 6 lb. of steam per hour per square foot of boiler-heating surface. As the boiler in question has 400 sq.ft. of heating surface, the required safety-valve relieving capacity should be $400 \times 6 = 2{,}400$ lb. of steam per hour; and according to paragraph 269, as the required relieving capacity exceeds 2,000 lb. per hour, there must be two safety valves having a combined relieving capacity of 2,400 lb., or 1,200 lb. for each valve, at the maximum allowable working pressure of 150 lb. gage. Turning to "Table 15, Discharge Capacities for Direct Spring-Loaded Pop Safety Valves with 45 Deg. Bevel Seats" (page 117, A. S. M. E. Code), opposite gage pres. 150 lb. per sq.in., find the nearest capacity quoted to cover 1,200 lb. per hour is that of a 1¼ in. diameter valve with lift of 0.05 in. and relieving capacity 1,355 lb. per hour. Hence, the boiler should be supplied with two such valves.

The Use of Oil in Cleaning Coal

By an Application of the Principle of Differential Wetting the Trent Process Makes Use of Oil to Recover High Grade Coal from Coal Waste and Thus Opens Up Great Possibilities for Conservation of Fuel Resources

Every power-plant engineer should be interested in a general outline of the Trent Process, by which it may be possible to recover much of the coal that is now being wasted at the mines and elsewhere. In the first part of this article O. P. Hood, of the United States Bureau of Mines, tells something of the development of the Trent Process and then proceeds to outline extensive fields for its practical application. Following Mr. Hood's introduction and under the subtitle "Outline of Experiments," is an abstract of a paper by G. St. J. Perrott and S. P. Kinney, of the Bureau of Mines. This paper was recently released under the title "Laboratory Studies of the Trent Process."

DURING the war certain suggestions concerning power production were made by Walter E. Trent to the War Inventions Board, and at the request of the War Department facilities for experimental work were provided on the grounds of the Bureau of Standards.

The experiments were along the line of controlling the conditions of combustion in a closed space. In order to reduce slag troubles, experiments were carried out for removing ash from powdered coal. After the war work along this line was continued, resulting in the Trent Process, which agitates or beats together powdered coal, water and oil.

A new technology had previously been given to ore preparation by the use of small quantities of oil in water with froth flotation, and although the methods, results and mixtures of the Trent Process were quite different, the same physical phenomena of differential wetting were used and the possibility of there being interesting results in fuel technology was evident. A co-operative agreement was entered into, whereby the Bureau of Mines was to investigate the underlying physical and chemical facts and make them public, and the Trent Corporation was to pay the cost of the investigation.

The several reports as made have been available to anyone interested and are now to be published. While the Bureau of Mines felt justified in investigating the physical phenomena so far as might be done in a laboratory and so far as public interest might reach, no attempt was made to discover the commercial possibilities that development might bring. The question of commercial possibilities must be left for commercial enterprise to answer.

Briefly, the process consists in agitating together powdered coal, water and oil. This produces a partly de-ashed plastic fuel, called an "amalgam," the oil selecting the coal particles and largely excluding the water and ash. The amalgam can be freed from water mechanically held by working, much the same as butter is worked.

This amalgam can be burned in several ways; for example, it may be shoveled or forced through pipes by pressure; it can also be stored under water if desired. The laboratory results immediately suggest many interesting possible applications.

For pulverizing fuel, wet grinding presents many advantages over dry grinding, provided the water can be eliminated afterward.

To be able to reduce the ash in coal may make available great quantities of low-grade coals and material now considered as waste at the mines.

If an oil is used that can be distilled at a temperature below the distilling temperature of the coal, powdered fuel is reclaimed from the amalgam and the oil may be re-used. If a heavy oil be used and distilled to dryness a coke product may be recovered, although the coal may have had no coking quality. If the distillation proceed only to a heavy pitch, a mass suitable for briquetting may be made.

In distilling oil mixed with a finely powdered material the distillates are similar to those obtained by distilling under pressure, so that the distillation of an amalgam of coal and oil gives quantities often more favorable than the sum of the separate distillations of the coal and the oil.

The amalgam can be used for a gas-making fuel, and gas-house-tar emulsions can be dehydrated by mixing with powdered coal, the amalgam being retorted for further gas making.

Graphite ore can be separated from its gangue, and coke can be separated from flue dust by using the Trent Process. Clean coal in anthracite sludge will make an amalgam if oil is added.

This brief sketch of possibilities revealed by small-scale laboratory work shows that the field for investigation and development is large. The general results show that real benefits are physically possible by treating coal in this manner. The bureau has interested itself more particularly in the ash-separation phenomena or the cleaning of coal, as outlined in the following paper, and in the distillation of the amalgam, which will be discussed in a future article.

Outline of Experiments

When a mixture of pulverized coal and water is agitated with oil in an amount equal to 30 per cent of the weight of the coal, a clean separation of a considerable part of the mineral matter is obtained. The carbonaceous material forms with the oil a pasty mass that is heavier than water, while the mineral matter that was physically separated from the carbonaceous material by the fine pulverization remains suspended and can be drawn off with the water.

The mineral matter in coal is classified (1) according to its physical state of subdivision as "intrinsic" and "extraneous" and (2) according to its chemical composition as shale, clay, "slate," sand calcite and pyrite. Intrinsic impurities are those that are present in a very fine state of dissemination throughout the coal substances and are not separated from the coal substance even by very fine pulverization. Extraneous impurities occur in the form of partings, veins and nodules or may be impurities mechanically mixed with the coal during the process of mining. Part of this extraneous mineral matter is removed by the standard methods of washing coal, the amount removed depending on the fineness of crushing necessary to insure physical separation of mineral matter from coal substance and on the size of crushed coal that the washery can efficiently treat.

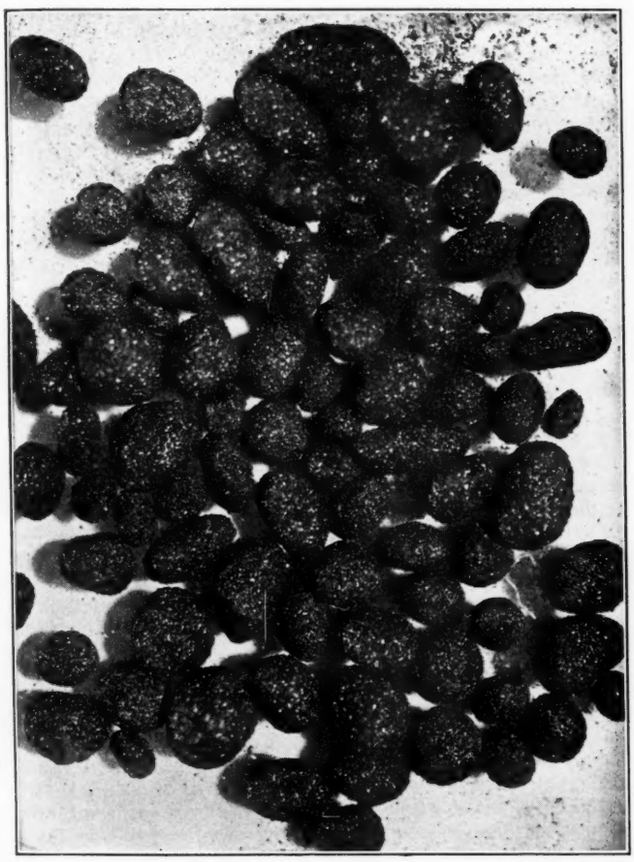
A later Bureau of Mines paper will set forth the results obtained in an investigation by J. D. Davis, fuels chemist, Pittsburgh Station, Bureau of Mines, on the recovery of oil from the coal-oil mass by distillation.

The theory of the Trent Process is briefly as follows: Coal particles are more easily wet by oil than by water. Moreover, the particles of coal are more easily wet by the oil than are the particles of refuse. The result is that when oil is stirred into a mixture of powdered coal waste and water, the particles of coal are gradually separated from the water and form with the oil a pasty mass containing only a small amount of refuse. If this pasty mass is then removed from the mixture and separated from its oil, there is obtained a powdered coal containing a low percentage of refuse. Naturally, the method will give best results only where the combination of coal refuse and oil is such that the oil has a much greater "attraction" for the coal than for the refuse.

Tests made with a number of typical coals of the United States gave an ash reduction varying from 30 to 75 per

cent. Sulphur reduction was fairly good in the case of anthracites, but low in the case of bituminous coals. Combustible recovery was with a few exceptions better than 95 per cent. Results point to the desirability of preliminary water concentration of high-sulphur coals for removal of pyrite before treatment by the Trent Process. Practically any oil of viscosity not greater than 135 sec. on the Saybold viscosimeter at a temperature of 25 deg. C. will give satisfactory results in this process. Oils of much higher viscosity may be used under certain conditions.

In most of the work the amount of oil required was about 0.3 lb. per pound of dry-cleaned coal. In the case



PHOTOGRAPH SHOWING LUMPS OF OIL-COAL AMALGAM (ACTUAL SIZE)

of a coal containing 25 per cent of removable refuse, it would be necessary to use 450 lb., or about 62 gallons, of a light fuel oil per ton of raw coal treated. The results obtained point to the conclusion that oil losses in the first stage of the process—that is, agitation and separation of refuse—will be negligible. Recovery of oil from the mass of oil and coal by distillation is another matter and one outside the scope of the present article. The amount of moisture in this mixture may range anywhere up to 30 or 40 per cent, although it is usually considerably less.

This process is, of course, applicable only where the coal has been ground to a powder. It has been found that grinding finer than 200-mesh does not give sufficiently greater ash reduction to pay for the increased cost of finer pulverization.

In the case of raw lignite it has not been found possible to get good separation of carbonaceous material from mineral matter for the reason that lignites are very readily wetted by water. Once the lignite is well wetted with water, either by wet grinding or by soaking, the moisture is not readily displaced by oil. On agitation of a wet-ground mixture of lignite with oil, there is some tendency for separation into layers of coal-oil and refuse-water, but no formation of compact agglomerate or "amalgam" of coal and oil which takes place with bituminous coals or anthracites.

Petroleum Standardization Committee

The Technical Committee on Standardization of Petroleum Specifications has been considering a number of proposed changes in the Federal specifications for the purchase of gasoline, kerosense, fuel and lubricating oils, and for this purpose held a meeting July 12 at Washington. Representatives of the various Governmental agencies interested in the purchase of petroleum products and members of the technical staff of various refining companies were present, and N. A. C. Smith, petroleum chemist of the Bureau of Mines, and chairman of the committee, presided.

The general sentiment of the meeting was that the new testing methods of the American Society for Testing Materials should be adopted, though it was pointed out that the new methods were still in the tentative stage, and that the committee would do well to give careful study to each one before adopting it. The possibility of omitting certain tests now employed was discussed, and the conclusion was reached that the acid heat test for gasoline and the cold test for steam cylinder and black oils are unnecessary. It was brought out, however, that the fire test for lubricants is of value as a check on sampling and should be continued in the specifications.

In view of the fact that the specification for fuel oil for Diesel engines, which had been intended to cover a very high grade of oil for submarines, has been criticised as being too stringent, a revision of the fuel-oil specifications was proposed to show how several of the present grades can be used for Diesel and other oil engines. The raising of the permissible water and sediment from 1 to 2 per cent was advocated with the penalty attached for all water and sediment above 1 per cent. It was shown that testing the viscosity of fuel oils at 77 instead of 70 deg. F. would be in harmony with the work of the American Society for Testing Materials.

It was pointed out that further definiteness would be desirable in the test for emulsifying properties of lubricants. Most of the discussion on lubricants centered around classes A, B and C. It was shown that the words light, medium, etc., as applied to these oils have different meanings when the oils are used for different purposes, and a system of numbering was advocated to replace the present names for the grades. A slight broadening of the viscosity limits was suggested in order to allow several commercial grades of oil to qualify under the specifications, and a relaxing of the color- and pour-test standards was advocated for the same reason.

At the close of the meeting Chairman Smith announced that he would tabulate the various suggestions made and would, within a short time, call a meeting of the Technical Committee to vote on the final form of the revisions, which would then be submitted to the Interdepartmental Committee for approval and publication.

The Committee on Standardization of Petroleum Specifications, frequently known as the Presidential Committee, was a war-time committee originally under the direction of the Fuel Administrator, but later transferred to the Bureau of Mines. Bulletin 5 was its last official publication and contained all the committee's testing methods and specifications in their latest revised form. This war-time committee went out of existence Jan. 18 of this year, when the President authorized the Secretary of the Interior to form a new Interdepartmental Committee on Standardization of Petroleum Specifications.

The new committee met and organized on Feb. 19 and adopted Bulletin 5 pending its revision. Each member of the committee appointed a technical representative, and these representatives were directed to form a Technical Committee to consider the revision of Bulletin 5 and to make recommendations in the matter to the Interdepartmental Committee. This plan was used successfully by the previous committee. The Technical Committee has met twice and has compiled a list of suggested changes and additions to Bulletin 5. Neither committee has yet voted on these proposals, but it is now planned to compile them in final shape, and the Technical Committee will then decide what recommendations it will make to the Interdepartmental Committee.

Waste in Metal Trades Industry

Idle men and machinery are causing an annual loss of nearly a billion dollars a year in the metal trades industry, says a report issued by the Committee on Elimination of Waste in Industry of the American Engineering Council. This estimate covers the value of labor only and does not include the value of materials that would be utilized if the productivity of labor were increased.

The metal trades findings are a part of the general report made by the committee on its national assay of industrial waste, directed by L. W. Wallace as vice chairman. The chairman of the committee is J. Parker Channing. The metal trades investigation was in charge of Fred J. Miller and William B. Ferguson.

Among the main causes given for waste or inefficiency are the following: Fluctuation of demand for product; the railroad situation; lack of standardization of design of products; strikes; lack of efficient planning and management methods; lack of co-operation between management and labor; unemployment of available labor and equipment due to the general business depression; labor turnover.

Particular emphasis is laid on the last item, "labor turnover," which causes an enormous and never-ceasing loss in good times and in bad. For instance, in the metal trades industry alone, with practically two million employees and with an average of one change of position per year per employee, the yearly loss due to labor turnover comes to $100,000,000, if it be assumed that it costs only fifty dollars to break in a new man. Expert estimates of the cost of breaking in a new man range from $50 to $250.

Boiler-Water Analyses

In a paper presented before the American Society of Mechanical Engineers at the Spring meeting, Chicago, May, 1921, J. R. McDermet[1] called attention to the fact that it is only the relatively pure waters which produce dangerous conditions, and as the sum of dissolved solids decreases, the liability toward corrosion disproportionately increases. Beyond an impurity content of 300 parts per million, corrosive waters are almost invariably of abnormal chemical analysis so that the danger is immediately apparent. Below 50 to 60 parts per million, the technical analysis, even if it shows no unfavorable features, is usually insufficient unless the history of the origin of the water is definitely known. For such waters as these a sanitary analysis is a distinct contribution.

The Sanitary Analysis

The sanitary analysis is more truly a series of tests in which the reaction of the water is observed as indicative of the pollution that it has undergone, than a determination of foreign constituents. Technique has been so highly developed by the sanitary chemist that it is possible for him to tell from the values obtained in analyses the extent of the pollution and its sources—whether they be industrial, organic vegetable, or wastes from animal or human sources.

Industrial pollution usually manifests itself in the form of some characteristic compound which is a byproduct of processes of manufacture. Aside from mine and paper-mill wastes, which usually reveal themselves unmistakably in the technical analysis, this class of pollution may occur in extreme dilution and yet be harmful in pure waters.

Under the heading of organic vegetable contamination may be grouped the products of algal growths, water plants in stagnant bodies of water, and the run-off from uncultivated land, particularly marshes, and deforested or forest fire areas. Chemically such contamination manifests itself either as acidity due to weak organic acids, or as nitrogen compounds. In the power plant the physical damage resulting from organic acids appears principally in the corrosion of saturated-steam lines, turbines, and vapor spaces of condensers; in other words, in apparatus where moisture accumulates from partial condensation. Unlike dissolved-gas contamination, the feed lines and boilers where the dilution of the acids is very great are reasonably exempt, and the corrosion does not exhibit its greatest vigor in a narrow zone of temperature. Undoubtedly, the presence of dissolved oxygen accelerates the corrosion, but the organic acids polymerize or change their form rapidly and the action is not indefinitely cyclic as in the case of some mineral acids.

Nitrogen compounds—and in particular ammonia—originating in organic vegetable pollution confine their attacks principally to copper and brass fittings and the iron is exempt in the path of steam flow. In dead-end spaces serious corrosion may occur on both ferrous and non-ferrous metals, but aside from this the damage is usually inconsequential. Dissolved carbon dioxide in appreciable concentration due to bicarbonate alkalinity accelerates corrosion.

Sewage contamination may be classified as recent or remote, and further divided into household refuse and animal or human excrementitious matter. The latter, unless it exists in a quantity that contributes a dangerous chlorine content, sludges in the boiler and may be dismissed without further comment. Oleaginous matter and greases from household wastes, if of recent origin, contribute to foaming, priming and corrosion much as do organic acids if in considerable concentration. Sewage of remote origin which has been oxidized by aëration and bacteria action shows high nitrate content and sometimes nitrites, depending upon the extent of the natural purification. While the criteria in such cases are the nitrate content and the qualitative presence of nitrites, the introduction of both of these into a boiler water in any concentration is earnestly to be avoided.

The Dissolved-Gas Analysis

The analysis for dissolved gases is confined entirely to the determination of dissolved oxygen.

It is impossible with commercial pipe materials to formulate an opinion as to how long a hot-water boiler-feed pipe system will last. It appears, however, that if the oxygen content is kept below 0.7 c.c. per liter (0.7 part in 1,000 by volume), the gas volume being reckoned under standard conditions, the life of the feed lines will be of such a length as to prevent ascribing the ultimate failure to oxygen. It may be taken as axiomatic, however, that the reduction of oxygen content to the lowest consistent value is always a desirable precaution.

Boilers that operate below rating rarely suffer any damage, whatever may be the oxygen content of the feed water. As the rating goes up, however, damage appears, but if the concentration is kept below 1.0 c.c. per liter the boiler seldom experiences pitting action. Boiler scale is a fairly efficient protective agent against this form of attack. Unfortunately, scales of predominant silicate or pure sulphate composition introduce a different corrosion loss, in that there is an amalgamation at the boundary between the iron surface and the scale through the intermediation of iron oxide. The use of mechanical tube cleaners in removing this scale results in a severe detrition loss from the iron surfaces which may very markedly shorten the life of the boiler. The removal of oxygen from the boiler feed to the extent that existing apparatus is able to accomplish it, does away with this amalgamating action, and these classes of impurities in the absence of heavy carbonate formations become self-scaling.

Boilers rarely present simple corrosion phenomena Usually trouble arises from a complexity of causes. Corrosive dissolved solids which yield free acid radicals and dissociated acid radicals and dissolved oxygen are mutually accelerants of pitting action. With such boiler waters the removal of dissolved oxygen is a worth-while alleviation and a guarantee against regenerative action with a stable acid ion, but it is not a cure. Chemical treatment of the water is the most logical corrective if it is properly controlled and is not based on excessive alkalinities; but in practice the results obtained are usually far short of the ideal and need to be supplemented. The pitting of the surfaces presents the same general appearance. Where it is directly chargeable to dissolved gases, the action is more or less selective, in that the area of greatest virulence is confined to parts where the circulation is sluggish, and entirely to the water space. In boilers subjected to severe acid corrosion, however, the pitting may extend into the steam space.

[1]Research Engineer, Elliott Company.

Low Load Factor in the Coal Industry

The Geological Survey has prepared an extensive report on "Seasonal Fluctuations in the Production and Transportation of Bituminous Coal" at the request of Senator Frelinghuysen in connection with his Seasonal Rates Bill. The bill was based on the belief that one of the largest causes of waste in soft-coal production is what might be termed "low load factor"; that is, extreme seasonal variations in demand, and therefore in production. To cure this condition, it aimed to establish seasonal rates for the transportation of coal, such that consumers would find it worth their while to buy in slack periods and store the coal for later use. The bill was killed in the Senate by a 38 to 26 vote on a motion to recommit, but the Survey's report remains of considerable interest.

Among the many questions that are bound to arise in considering this subject, two of especial importance are: "How greatly does production fluctuate?" and "Would storage be feasible as a remedy?" As the Survey's answers

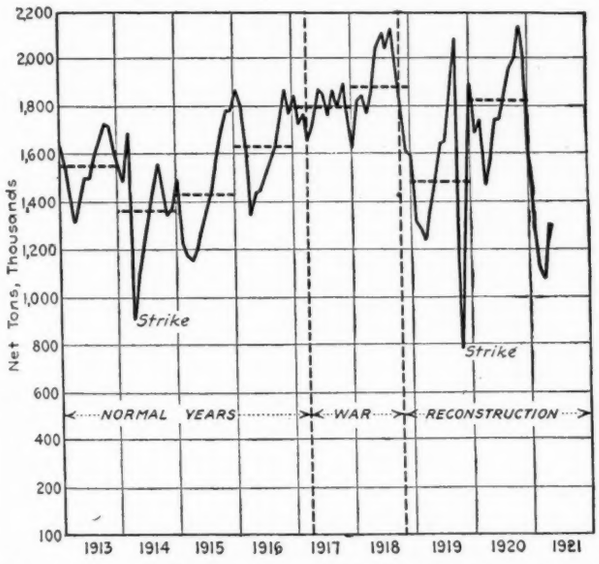


FIG. 1. EIGHT YEARS OF FLUCTUATION IN BITUMINOUS-COAL PRODUCTION

The curve is based on the average production per working day for each month from 1913 to the present time. The horizontal dotted lines represent the daily average for each year.

to these questions, three charts from the report have been reproduced here.

Fig. 1 presents a bird's-eye view of coal production for the last eight years. The violent ups and downs of this "curve" tell the story of inconstant output very plainly. It is interesting to note from this chart that the slump in production that started in the fall of 1920 and stopped quite recently was unequaled during the preceding eight years, except for the great strike of 1919.

Fig. 2 shows the effect of this condition upon the working of the mines. Seasonal variations in demand and the resulting slack periods in production are held responsible for the largest part of the time lost out of the available number of working days, and this loss has been calculated to be 44 days out of the possible 308.

The loss of 34 days through "sheer overdevelopment" simply means that the maximum capacity of all the mines in the country is considerably greater than what the requirements would be if demand were constant and unvarying. In other words, there are so many mines in the country and they are developed to such a point that if they should keep up to their maximum rate of production, they would produce enough coal for the year's requirements 34 working days before the end of the year. The result is that these 34 days are spread over the entire year in the form of reduced hours. This inevitably causes decreased efficiency.

Fig. 3 indicates that existing storage facilities are sufficient for the storing of enough coal to eliminate seasonal variations in demand. The Survey has estimated that, if 21,000,000 tons were stored between March and August, in addition to the probable normal stock of 40,000,000 tons in the late autumn, production and transportation could be equalized throughout the year. The fact that the total

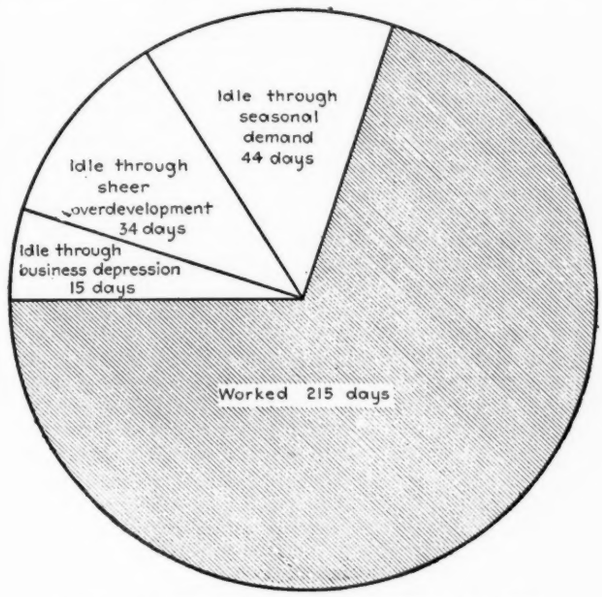

Idle through seasonal demand 44 days
Idle through sheer overdevelopment 34 days
Idle through business depression 15 days
Worked 215 days

FIG. 2. HOW THE YEAR IS SPENT IN THE SOFT-COAL MINES

Out of the total of 308 working days a year available, American soft-coal mines have worked on an average of but 215 days a year over a period of 30 years, from 1890 to 1919.

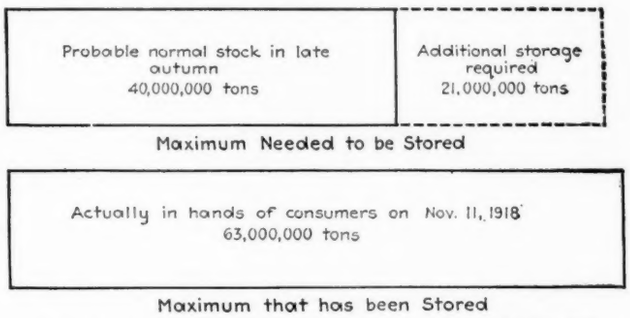

Probable normal stock in late autumn
40,000,000 tons
Additional storage required
21,000,000 tons
Maximum Needed to be Stored
Actually in hands of consumers on Nov. 11, 1918
63,000,000 tons
Maximum that has been Stored

FIG. 3. HOW SEASONAL FLUCTUATIONS COULD BE ELIMINATED

To equalize the production and transportation of soft coal throughout the year would require the putting in storage between March and August of about 21,000,000 tons more than is already stored. This would make the total quantity in storage no greater than the actual stock on Armistice Day, as reported to the Fuel Administration.

required to be stored—61,000,000 tons— is less than the amount that was actually reported in storage on Armistice Day is given as proof that adequate storage is feasible.

Switzerland is now using her utmost endeavor to develop her immense resources in water power, which are officially estimated to contain a capacity of four million horsepower. At the beginning of 1921 a total of 171 works—of over 500 hp.—had been erected or were in process of erection, while 190 works—of over 1,000 hp.—had received or had applied for the necessary authorization for construction. Among the power stations already built or building are five with from 60,000 to 68,000 hp., one of 52,000, one of 48,600, three of 45,000, one of 42,000, one of 40,800, and ten of from 20,000 to 32,600. Among the projected stations are fifteen of from 60,000 to 200,000 and eleven more of 50,000 to 55,000.—*The Engineer.*

A 3,000-Horsepower Opposed-Piston Type Marine Oil Engine

The Engineer, in the issue of June 17, 1921, page 633, describes the largest marine oil engine of the opposed-piston type in the world. It was built by William Doxford & Sons and develops 3,000 indicated horsepower at 77 r.p.m., corresponding to 2,600 brake horsepower. It is of the two-stroke-cycle solid-injection type, and the compression pressure does not exceed 300 pounds per square inch.

Each of the four cylinders has a bore of 580 millimeters (22⅞ in.), is self-contained and stands separately from the other cylinders, except for the exhaust manifold and scavenging-chamber connections. The stroke of each piston is 1,160 millimeters (45⅝ in.), giving a total stroke of 2,320 millimeters (91¼ in.) for both pistons. The bottom piston drives a center crank and the top piston two side cranks through the medium of a tee-shaped crosshead and two connecting rods, one on each side of the cylinder.

The scavenging ports are arranged around the periphery at the bottom of the cylinder. As the lower piston uncovers the scavenging ports air is forced into the bottom of the cylinder at a pressure of 2 lb. per sq.in. and drives the burnt gases upward and out through the exhaust ports into the water-cooled silencer.

On the return stroke the air is compressed to about 300 lb. and the fuel injected at about 1000 lb. per sq.in. Since the compression is too low to ignite heavy fuel oil, each piston carries a projection in forged ingot steel that is not water-cooled and remains at a sufficient temperature throughout the cycle to ignite the fuel. In starting the engine, the pistons must be warmed by circulating hot water or steam around them. The valve mechanism is simple, limited as it is to the operation of the fuel and starting-air valves.

The oil consumption, using heavy Mexican oil of 0.916 specific gravity, was about 0.441 lb. per brake horsepower-hour during a seven-day non-stop trial trip. The total lubricating oil consumption was 19½ gal. per day.

The low-speed of 77 r.p.m. was chosen to make the engine suitable for use on single-screw freighters. The piston speed, 586 ft. per min., is correspondingly low. The engine is unusually flexible and operates with perfect smoothness at 17 to 18 r.p.m. It is comparatively heavy, weighing over 300 tons, and is 44 ft. long. However, it is estimated that a freighter equipped with this engine will have 8 per cent greater freight capacity than a steamer of the same size.

Secretary Hoover Comments on Business Situation

There is much food for thought in the address recently made by Secretary Hoover before the National Association of Real Estate Boards in Chicago. Speaking on the subject "Constructive Forces in the Solution of the Housing Problem," Mr. Hoover made the following comments on the business depression:

If we would study the cause of this depression and the remedies for it we should devote our time to the examination of the economic phenomena of the war and of the post-war boom. From the war we have the necessity to recover many losses and to change our productive forces in accordance with the tremendous economic shifts in the world. Spreading over all this, however, lies the fact that this depression is to a great degree born of the malevolent forces we set in motion by inflation and by all booms. It is in the booms that we speculate, overextend our liabilities, slacken down in effort, lower our efficiency, waste our surplus in riotous living instead of creation of new capital, drive our prices to vicious levels, and lose our moral and business balance. We must suffer a period of duress from war and punishment for the boom until we rebuild our virtues of hard work, frugal living, more saving, sober conduct, and higher honesty. These things are trite enough, but they are as immutable as history, and this is the only way out. There are a few people who will not accept these hard facts, who will persist in the notion that they can by various devices avoid reaping what they have sowed. The resistance of a few groups of manufacturers or dealers to lowering prices to the general level; the resistance of a few groups of workers to accommodation of their wage to the decreasing cost of living and the necessity of a better day's work; the refusal of some people to curtail their extravagance—all these contribute to our undoing. They have to come into the cold water in the end. They can not get more than their ration of the total. In the meantime they delay recovery and contribute to unemployment among the rest of us.

However, the vast majority of us have cheerfully accepted the inevitable. I have records showing that in most manufacturing industries efficiency has increased from twenty to thirty per cent during the past twelve months. Our farmers are making extraordinary efforts. They are economizing in supplies and machinery; they are making the old things do a little longer; and they will bring in this year's crop at a much less cost than for many years past. Thus at least 80 per cent of our people have accepted these homely truths and taken those steps that are primary to overcome any depression. These people have adopted that slogan "give a full measure" which St. Luke announced as a fundamental of economics some 1,900 years ago. That is why I insist we have turned the corner.

Waste in the Building Industry

Mention is made elsewhere in this issue of the report on waste in the metal trades industry by the Committee on Elimination of Waste in Industry of the American Engineering Council. The committee's report of its investigation of the building industry is equally interesting and illuminating.

The building industry adds approximately $3,000,000,000 yearly to the national wealth and employs some 3,000,000 mechanics and laborers in a single year. The chief sources of waste in this industry are, according to the report, irregular employment, inefficient management, accidents and wasteful labor regulations. Customs or conditions prevailing throughout the industry and poorly designed equipment are given as secondary causes.

The loss from irregular employment is particularly serious in this industry, where the workman averages only 190 working days in the year. This is due chiefly to seasonal demand, although strikes and lockouts are appreciable causes. It will require the utmost co-operation among labor, the contractors and the general public to bring about a more sensible distribution of building activities throughout the year.

One hopeful sign is that it is beginning to be generally appreciated that the elimination of waste benefits labor and the general public even more than it benefits the contractors.

A. S. M. E. to Co-operate in Ordnance Development

To speed the Government's post-war program for ordnance development, the Ordnance Division of the American Society for Mechanical Engineers is planning to work with the War Department at close range. The division, through its executive committee, has voted to place its resources at the disposal of the Ordnance Department for the solution of engineering and production problems.

A joint meeting will be held on October 7 of the American Society of Mechanical Engineers, the Society of Aëronautic Engineers and the Army Ordnance Association at the Aberdeen Proving Grounds. The Ordnance and the Aëronautic Divisions of the A. S. M. E. will take part in the meeting. Orville H. Wright and others well known in air navigation are members of the Aëronautic Division of the A. S. M. E.

Questions vitally affecting the future of American ordnance will be discussed at the October meeting, which will attract leading army officers and engineers from all over the country.

Major G. F. Jenks, Ordnance Department, U. S. A., in a survey of progress in ordnance since the Armistice, made for the A. S. M. E., asserts that the American army gun of the future will be of greater range and mobility. He tells of research work now under way at the Watertown Arsenal and of the lessons learned by American Army heads from the war. The present tendency, according to Major Jenks, is toward more powerful guns for seacoast defense. The further statement is made that the elimination of the horse, the perfection of the gas engine and the development of the automobile are important factors.

The American Society of Mechanical Engineers, as a further step in its general policy of co-operating with Government agencies in engineering tasks, authorized the formation of an ordnance division so that the nation's engineers might be brought into intimate contact with the army. The division, formed with the co-operation of Major General C. C. Williams, Chief of Ordnance, U. S. A., is now a permanent unit of the society's elaborate system of professional divisions having to do with a wide range of economic and technical problems.

Under the chairmanship of Waldo H. Marshall of the T. A. Gillespie Co., the executive committee of the division is carrying out plans which originated with engineers and ordnance men in 1918 as a result of the active participation in the Government's ordnance program during the war. Aiding Mr. Marshall as members of the committee are Col. C. L. H. Ruggles, Chief of the Technical Staff, Ordnance Department, U. S. A.; Fred J. Miller, past president of the A. S. M. E.; Lieut. Col. George L. Wall, stationed at the Watertown, Mass., Arsenal; Major Wilford J. Hawkins, Bloomfield, N. J., and Major Edward L. Sherwood, Hohokus, N. J.

Others interested in the formation of the Ordnance Division are Major F. C. Bull and Frederic E. Town, of New York; Frank B. Gilbreth, of Montclair, N. J., manufacturer, and Col. James T. Walsh, representing the Army Ordnance Association, who are co-operating with the division in the attempt to put the United States to the forefront of the world in ordnance manufacture and design.

In recent years the demand for gasoline has increased more rapidly than the supply obtained from the distillation of petroleum. This has resulted in the extended use of the processes for the recovery of gasoline from natural gas. Two processes are in use—the compression process for the wet gas that occurs with oil, and the absorption process for the dry gas found elsewhere. The following production figures for the year 1919 are given by the United States Geological Survey:

Gasoline produced from natural gas:	
By compression process	261,157,587 gal.
By absorption process	90,377,439 gal.
Gasoline produced from petroleum	3,833,672,295 gal.
Total gasoline produced	4,185,207,321 gal.
Volume of natural gas treated:	
By compression process	117,669,332,000 cu.ft.
By absorption process	374,928,966,000 cu.ft.
Average gasoline yield per thousand cu.ft. of natural gas treated	0.74 gal.

The recovery of gasoline from natural gas does not destroy the gas from which it is taken or impair its value. In fact, the process actually improves it for domestic and commercial use by removing the water as well as the gasoline, which disintegrates the rubber gaskets and thus causes leaks in the conveying pipe. The natural-gas gasoline industry is, therefore, one in which there is 100 per cent conservation.

It is not beyond the bounds of reason to foresee a condition whereby a householder, in the place of his ton of anthracite . . . will receive a ton of smokeless coal without slate, a month's supply of cooking gas, forty miles of motor fuel, enough fertilizer to start a small garden, and tar sufficient to allay the dust in front of his house—all for far less money than he now pays for inferior coal.

The foregoing statement, taken from Bulletin 102 of the National Museum, was recently quoted by S. M. Darling, fuel engineer of the Bureau of Mines, with the statement that the picture was not a fanciful one and that our high-volatile coal and lignite contain exactly these possibilities within themselves. The quotation and the comments on it were made in a paper on the "Possibilities of Sub-Bituminous Coal," read before the Twelfth Annual Convention of the International Railway Fuel Association.

Molecular and capillary attraction are possessed to a greater extent by mineral oils when properly refined, than by either animal or vegetable oils, but mineral oils are deficient in oiliness and will not keep the static friction as low as do animal or vegetable oils.

Consumption of Coal According to Principal Uses

The uses of coal are classified in the following summary issued by the U. S. Geological Survey as a portion of its weekly coal report dated July 23. Although the actual tonnages do not apply strictly to other years than 1917, the proportion probably is much the same for any typical year. In commenting on the table, the Survey issues the following comment and warning:

It must be remembered that consumption is not the same as production. Not only must exports and imports of coal be taken into consideration, but the flow of coal in and out of storage must be reckoned with. Further, there is great variation in the quantity of coal actually consumed from year to year, depending to some extent on the weather and to much greater degree on the activity of the industries which are the chief consumers of coal.

The proportion of the total coal consumed, taken by different industries, does not vary so greatly, and the percentages shown in the table below are roughly constant from year to year. The table represents in a general way the conditions during 1917, a year of large consumption. The principal changes since 1917 have been an increase in the proportion exported and a transfer of some millions of tons from beehive to by-product coke. The proportion consumed by the two types of coke ovens combined has undergone little change.

COAL CONSUMED IN THE UNITED STATES AND EXPORTED

(The figures for bituminous coal in this table represent in somewhat generalized form the calendar year 1917; those for anthracite, the coal year ended March 31, 1917.)

	Quantity (Net Tons)	Per Cent
Bituminous coal:		
Industrial plants	174,600,000	31.7
Public utilities:		
Electric	31,700,000	5.8
Gas	4,960,000	0.9
Railroads	153,700,000	27.9
Domestic consumers	57,100,000	10.3
Power and heat at mines	12,100,000	2.2
Exports	22,900,000	4.1
Bunkers:		
Foreign trade	6,700,000	1.2
Coastwise and Lake trade	3,600,000	0.7
Beehive coke	52,240,000	9.5
Byproduct coke	31,500,000	5.7
	551,100,000	100.0
Anthracite:		
Domestic consumers (domestic sizes)	49,400,000	55.1
Artificial gas plants	1,650,000	1.8
Steam trade (industries, power plants, and heating large buildings)	18,450,000	20.5
Railroad fuel	6,400,000	7.1
Power and heat at mines	9,350,000	10.4
Exports	4,600,000	5.1
	89,850,000	100.0
Grand total	640,950,000	

The June, 1921, issue of the journal *Lubrication* states that the general opinion that engines with high superheat are hard to lubricate has arisen from the common practice of using heavy-bodied pure mineral oil. Unless a very high superheat is used, steam at the exhaust will show some moisture, and, since the cylinder must be lubricated on the exhaust stroke as well as on the expansion stroke, a slightly compounded oil should be used. It is stated that the use of a pure mineral oil has no doubt been due to the fact that cylinder oils were too often used which were not properly refined or compounded with such fatty oils as would withstand the carbonizing effect at the high temperature of superheated steam.

By royal decree of June 14, 1921, many restrictions have been placed on hydro-electric enterprises in Spain. One of these restrictions is that concessions shall be granted only to Spaniards or companies constituted and domiciled in Spain. Limitations are also placed on the number of foreigners who can belong to such a company and the positions they can hold. In addition the decree states that concessions for the exploitation of hydro-electric power shall be granted for a maximum term of 65 years, after which time all the work, machinery, transportation line and other elements of exploitation shall return to the state.

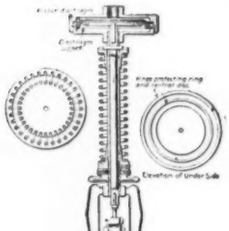
Condensed-Clipping Index of Equipment

Patented Aug. 20, 1918

Regulator, Wilkins Pressure

Wilkins Automatic Regulator Co., Erie, Pa.

"Power," June 28, 1921

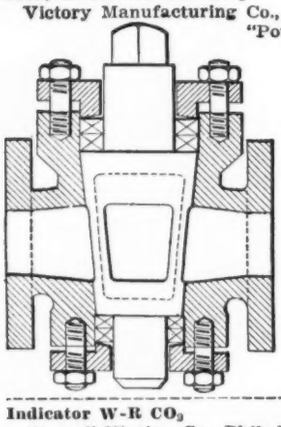


The principal feature of this regulator is the construction of the diaphragm, which is made of german silver and consists of a central disk and an outer ring, the two being connected by means of wire hinge loops. The hinges are protected by a protecting ring and center piece. This regulator is used in connection with stoker and forced draft engines for controlling their speed, and at the same time controls the opening and closing of the damper.

Cock, Double-Packed Stop

Victory Manufacturing Co., Niles, Cal.

"Power," 1921

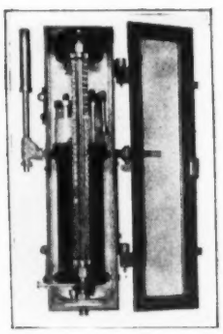


In the construction of this valve double lubricated packing is used, acting against the two ends of the plug in opposite directions. The pressure exerted by the upper gland can be relieved or balanced by adjusting the lower gland. This permits of adjusting the pressure on the plug so that it will turn easily and still be tight. The stuffing boxes act as guides to the plug at top and bottom ends. The protruding bottom stem permits of driving the plug out should it stick.

Indicator W-R CO_2

Yarnall-Waring Co., Philadelphia, Penn.

"Power," June 14, 1921

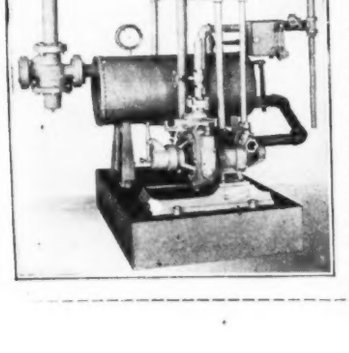


A CO_2 indicator designed for application, one for a boiler; requires no liquid reagent, is continuous, needs but little attention, and the percentage of CO_2 is registered on a graduated scale continuously. Gas is drawn from the last boiler pass to the indicator by a steam-jet aspirator. After passing through a secondary filter, a portion of the gas circulates through a porous pot, where it comes in contact with a dry reagent cartridge and the CO_2 is absorbed by it. The pressure in the porous pot is always less than that in the chamber surrounding it, and the difference in pressure is a positive measure of the CO_2 content of the gas, which is continuously indicated on a scale.

Pump, Jennings Turbine-Driven Return-Line Heating

Nash Engineering Co., South Norwalk, Conn.

"Power," July 5, 1921



In this design of pump the air pump that exhausts the air from the system, the centrifugal pump that removes the hot condensate and returns it to a feed-water heater or hotwell and the steam-turbine rotor to drive the unit are all mounted on one shaft and assembled in the same casing. It is designed for use in connection with heating or drying systems where the pump is called on both to maintain a vacuum on the heating system and to return the hot water and condensation against the pressure. All interior parts of the pump are constructed of bronze with the exception of the steam-turbine rotor.

Dilut-O-Meter, Lareliff

Lubricating Appliance Manufacturing Co., 1464 East 57th Street Chicago, Ill.

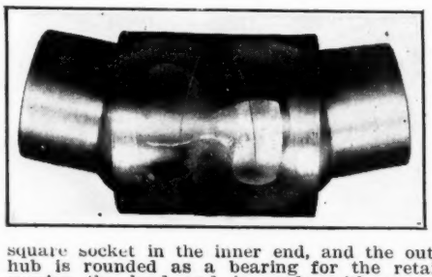
"Power," 1921

This instrument is for determining the life of crankcase oils of internal-combustion engines. As the oil becomes diluted, it gets lighter in body, thus allowing the stem of the instrument to sink farther below the surface of the liquid. By setting a sleeve graduated so that the zero point is at the surface of the new oil, and with this as an index point, the used oil can be tested as to its lubricating value. The graduations read "good" for new oil, "fair" for partly diluted oil and "poor" and "dangerous," according to the percentage of dilution.

Coupling, Whitney Free Floating

Kay Manufacturing Co., South Norwalk, Conn.

"Power," July 5, 1921



A simple, compact coupling that contains no flanges or pins and when connecting two machines gives a positive driving joint, but allows each machine to run freely in its own bearings. It consists of two hubs, a link, a casing and two retaining rings. Each hub is made with a square socket in the inner end, and the outside surface of each hub is rounded as a bearing for the retainer ring. The link carries the load and is made with square ends, with edges slightly curved to permit of free movement of the hub in the hub socket in any direction out of alignment. The coupling is made in several sizes, for ¾-in. to 6½-in. shafts.

Idler, Self-Aligning Conveyor

C. W. Hunt Engineering Corp., 143 Liberty St., New York City.

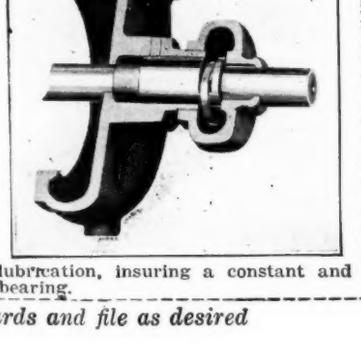
"Power," 1921

This all-steel self-aligning idler is made with pulleys 4 in. in diameter, each pulley having two bearing surfaces which are proportioned for the load to be carried. The pulley bearings are self-aligning, and the only parts requiring replacement are the self-aligning bearings themselves, which are interchangeable for all sizes of conveyors. The design of the idler makes it self-aligning, and steel construction is used throughout. A stationary channel of steel tubing supplies lubricant to all bearings from two grease cups, one at each end of the idler.

Gland Arrow Pump

Arrow Pump Co., Buhl Bldg., Detroit, Mich.

"Power," 1921



This gland construction eliminates leaky glands, scored shafts and short life of bearings, shafts and packing. As it provides a positive method of lubrication, it becomes practical to place the packing between the hot water and the bearing. The construction prevents entrance of any hot water or other substance into the bearings and prevents the lubricant from being washed out and confines it to the bearings, shaft and packing. The packing gland is arranged with a combination adjustment nut and oil reservoir, which permits of using the ring-oiling principle of lubrication, insuring a constant and positive flow of oil to the bearing.

Clip, paste on 3 x 5-in. cards and file as desired

New Publications

PATTERN-MAKING. By Edward M. McCracken, head of wood-working department, Johnson School, Scranton, Pa., and Charles H. Sampson, B.S., head of technical department, Huntington School, Boston, Mass. Published by D. Van Nostrand Co., 8 Warren St., New York City. Cloth, 8 x 11 in.; 112 pages. Price: $2.

An elementary book, primarily for students. According to the preface, it "is especially recommended for use in all technical, trade and vocational schools where the desire is to present a practical course in patternmaking." General principles of patternmaking and of foundry practice are discussed, hand and machine tools used in the pattern shop, and also the equipment of the foundry, are described and illustrated, and then "Exercises for the Student" are given. There is a great number of these examples, which show the application of the principles described previously. Illustrations are used in quantity, although the text is not so comprehensive as a man might wish if he had no teacher to help him. As a guide in class work, however, the book should prove valuable.

STEAM TABLES FOR USE IN CONDENSER WORK

The Wheeler Condenser and Engineering Co., Carteret, N. J., has announced the publication of the 1921 edition of "Steam Tables for Condenser Work." This is the sixth edition. The tables are in handy book form, pocket size. The properties of saturated steam are tabulated from 29.8 in. vacuum to atmospheric pressure in increments of tenths of an inch referred to a 30 in. barometer. The values were especially calculated for this book by Professor Marks. Above atmospheric pressure the increments are in pounds gage. The book explains how measurements are made by means of the mercury column and barometer, and gives constants and tables for making corrections. Corrections for the thermal expansion of mercury, for the relative expansion of mercury and brass scale, and other corrections are also included.

Obituary

John Beattie, chief engineer of the Metropolitan Life Insurance Company Sanitorium, died suddenly on July 8 of heart disease after an illness of eleven days.

Personals

Dr. Joseph W. Roe has reversed the usual modern practice by giving up a business career for a professorship, having recently received an appointment as professor of industrial engineering at New York University. In 1895 he was graduated from Sheffield Scientific School of Yale, where he remained on the faculty for a number of years. He then entered the business world and served with Henry R. Worthington Co., J. H. Williams Co. and Crane Co. At present he is executive engineer of the Pierce-Arrow Motor Car Co. "Trying to put one's life work into brains and character appeals to me more than putting it into iron and steel," is Professor Roe's explanation of his reason for returning to the classroom.

Society Affairs

Metropolitan Section, American Society of Mechanical Engineers, has re-elected as its chairman W. S. Finlay, Jr., of the American Water Works and Electric Co. G. I. Rhodes, of Ford, Bacon & Davis, was chosen secretary and Robert B. Wolf, of R. B. Wolf and Co., treasurer. The three officers and A. E. Allen, of the Westinghouse Co., comprise the section's executive committee.

Phoenix No. 24, National Association of Stationary Engineers, is planning to hold an outing on Sunday, Aug. 21, and has issued a cordial invitation to all engineers who are interested to join in a day of relaxation and frivolity at Duer's Park, College Point, L. I., N. Y. The grounds will be open in the morning for early arrivals, and a big lunch will be served at 2:30 p.m. Tickets, which will cost $3, may be bought at the park, but should preferably be secured from the secretary of the outing committee, William Wrightson, 242 West 31st St., New York City.

Miscellaneous News

A Minister of Power in the cabinet of Premier E. C. Drury of Ontario and a Department of Power in the government were indicated as possibilities by Mr. Drury in a Dominion Day speech. It is said also that J. C. Cridland, Norfolk's member of the Ontario Legislature, has stated privately that the creation of a ministry of power might be expected before long.

Business Items

The Atlas Valve Co. has moved its New York office to 242 Lafayette St. It is in charge of E. E. Jones, district manager.

The Chicago Belting Co., Chicago, Ill., has announced that Vance McCarty has been elected vice president and will take charge of all sales in New York and some of the neighboring Eastern States. Mr. McCarty was formerly vice president of Edward R. Ladew Co.

Trade Catalogs

The Freeman-Riff Co., Terre Haute, Ind., is sending out a bulletin describing its portable conveyors, which are made primarily to handle coal, but are also used for coke, sand, gravel, crushed stone and other materials.

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run basis, f.o.b. mines):

Coal	Market Quoting	July 19 1921	July 26 1921
Pool 1,	New York	$2.90	$3.00@3.25
Pocahontas,	Columbus	3.15	3.00@3.25
Clearfield,	Boston	2.00	1.70@2.15
Somerset,	Boston	1.80	1.50@2.00
Pittsburgh,	Pittsburgh	2.10	2.00@2.15
Kanawha,	Columbus	2.00	2.00@2.25
Hocking,	Columbus	2.15	2.00@2.25
Pittsburgh No.8	Cleveland	2.20	2.15@2.25
Franklin, Ill.,	Chicago	3.00	2.70@3.55
Central, Ill.,	Chicago	2.40	2.00@2.50
Ind. 4th vein,	Chicago	2.50	2.90@3.25
Standard,	St. Louis	1.70	1.70
West Ky.,	Louisville	2.25	2.00@2.65
Big Seam,	Birmingham	2.15	2.00@2.25
S. E. Ky.,	Louisville	2.20	1.85@2.50

New York—On July 6, Port Arthur light oil, 22@25 deg. Baumé, 4½c. per gal. 30@35 deg., 5½c. per gal. f.o.b. Bayonne, N. J.

Chicago—July 23, for 24@28 deg. Baumé, 40@45c. per bbl.; 32@34 deg. 1¾@1¾c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—On July 18, f.o.b. refinery; Pennsylvania, 36@40 deg., 3¼c. to 3¾c. Oklahoma, 24@30 deg. 40c. per bbl., gas oil, 32@34 deg., 1¾c. per gal., 36@38 deg., 1¾c. 38@40 deg. 1¾c.

St. Louis—July 23, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 35c. per bbl.; 26@28 deg., 35c.; 28@30 deg. 40c.; 32@34 deg. 1¾c. per gal.

Philadelphia—On July 26, 26@28 deg. Baumé, Oklahoma, 50c. per bbl.; 30@34 deg., Oklahoma (group 3) 75c. per bbl.; 16@20 deg. Seaboard, 3¼c. per gal.

Cincinnati — June 27, for 22@28 deg. Baumé, 6¼c. per gal.

Cleveland — June 27, for 22@28 deg. Baumé, 5c. per gal.

New Construction

PROPOSED WORK

Me., West Pownal—Dr. S. E. Vosburgh, Supt., is receiving bids for a 45 x 73 ft. central heating plant for State School for Feeble Minded here. About $70,000. R. D. Kimball Co., 6 Beacon St., Boston, Mass., Engrs.

Mass., Boston—The City will receive bids until Aug. 5 for a 4 story, 43 x 142 ft. hospital addition on Concord St. for the Boston City Hospital. About $350,000. Maginnis & Walsh, 100 Boylston St., Archts.

Conn., Greenwich—The Town, c/o G. E. Bearn, Chn., Bldg. Comn., 325 Greenwich Ave., is having plans prepared for a 3 story high school on Main St. About $1,000,000. Guilbert & Betelle, 2 Lombard St., Newark, N. J., Archts.

Conn., Middletown — The Connecticut State Hospital for Insane, South Farms, is having plans prepared for 100 x 235 ft. ward building at hospital here. About $300,000. D. K. Perry, 27 West Main St., New Britain, Archt. Noted Feb. 22.

N. Y., New York—M. Dreicer & M. Van Buren, c/o J. E. Carpenter, Archts., 681 5th Ave., plans to build a 9 story apartment on 95th St. near 5th Ave. About $350,000.

N. Y., New York—J. & D. Golding, c/o Rouse & Goldstone, Archts., 512 5th Ave., plans to build a 13 story, 100 x 300 ft. apartment on 90th St. between Bway. and Amsterdam Ave. About $750,000.

N. Y., New York—The New York Exchange, 107-11 Hanover Sq., is having plans prepared for a 23 story, 90 x 115 ft. bank and office building. About $2,250,000. E. M. Weld, Pres. D. Barber, 101 Park Ave., Archt. and Engr.

N. Y., New York—The Pershing Sq. Bldg. Corp. c/o J. Sloan, 570 5th Ave., will soon receive bids for a 24 story office building on Pershing Sq., 42nd St. and Park Ave. About $5,000,000. Noted Mar. 22.

N. Y., Schenectady—The City is having plans prepared for three, 3 story schools. About $1,000,000. W. T. Wooley, City Hall, Archt. and Engr. E. E. Palmer, heating and ventilating Engr.

Pa., Meadville—The Bd. Educ. will receive bids until Aug. 22 for a 2 and 3 story high school here. About $350,000. W. G. Eckles, New Castle, Archt. Noted June 21.

Pa., Newton Square—C. E. Ellis College for Girls, A. B. Wetherhall, 712 Commonwealth Bldg., Philadelphia, is having plans prepared for college buildings on West Chester Pike. About $5,000,000. J. T. Windrim, Commonwealth Bldg., Archt.

Pa., Philadelphia—F. H. Caven, Director, Room 216, City Hall, will receive bids until Aug. 5 for Mingo Creek pumping station.

Pa., Philadelphia — H. Childs Hodgens, Archt., 130 South 15th St., is receiving bids for a 7 story, 118 x 94 ft. office building on Juniper and Walnut Sts. for the Walnut St. Saving & Trust Co. About $500,000.

Pa., Philadelphia—T. F. Miller, Archt., 1012 Walnut St., is preparing preliminary plans for a 3 story bakery and power plant for the Logan Baking Co.

Pa., Verona—The Suburban Water Co., A. G. Garvin, Supt. will receive bids until Sept. 1st. for a 5 million gallon high duty pumping engine, crank and fly wheel and turbine driven centrifugal pumps.

Del., Claymont—The Bd. Educ. plans to build a high school. About $300,000. Coffin & Coffin, 522 5th Ave., New York, N. Y., Engrs.

Md., Baltimore—John Hopkins University, W. G. Boyce, Sec., University Parkway, is having plans prepared for three 3 story dormitories. About $250,000. E. L. Palmer, 1620 Munsey Bldg., Archt. C. L. Reeder, Park Ave. and Saratoga St., Engr.

Md., Baltimore — The South Baltimore General Hospital, T. W. Nesbit, 1213 Light St., is having preliminary plans prepared for a 3 story hospital addition on Light near West Sts. About $250,000. H. C. Jory, 1408 Munsey Bldg., Archt.

W. Va., Charleston—The Capitol Comn. is having sketches made for Capitol buildings here. About $5,000,000. C. Gilbert, 244 Madison Ave., New York City, Archt. and Engr.

N. C., Gastonia—The City voted $550,000 bonds for a new school building. R. G. Cherry, Mayor. Noted June 28.

O., Bay Village—The Northern Light & Power Co., c/o I. H. Case, Eaglecliff, is having plans prepared for a 1 story, 40 x 72 ft. power plant. About $75,000. A. W. Harris, Schofield Bldg., Cleveland, Archt.

O., Cleveland—Clayton Townes and H. A. Stahl, Hicox Bldg., plans to build a 10 story office building on East 18th St. and Euclid Ave. About $1,000,000. G. Rider & Co., Century Bldg., Archts.

O., Cleveland Heights—The Bd. Educ., E. K. Bryan, Clk., Lee Rd., will receive bids until Aug. 5 for a 3 story school on Taylor Rd. About $500,000. F. C. Warner, Hippodrome Bldg., Archt.

O., Elyria—The Bd. Educ. will receive bids until Aug. 9 for a 1 story, 40 x 60 ft. central heating plant with 1,000 hp. capacity. About $100,000. Ash and coal handling machinery will be required. Phegley & Szekeley, 5716 Euclid Ave., Cleveland, Engrs.

O., Greenfield—The Bd. Educ., c/o C. S. Main, is having plans prepared for a 3 story school including a steam heating system. About $300,000. W. B. Ittner, Bd. Educ. Bldg., St. Louis, Mo., Archt.

O., Troy—J. Stickel, Market St., plans to build a 2 story ice plant on Market St., electrically operated, 20 ton daily capacity. About $50,000. Private plans.

Mich., Bay City — The Garber Machine Co., Inc. is in the market for 2 to 35 hp. electric motors.

Mich., Detroit — The Bd. Educ., 1354 Broadway Ave., will receive bids until Aug. 16 for a 3 story, 82 x 246 ft. and 113 x 130 ft. school building including steam heating boilers, accessories and Plenum system on Brooklyn Ave. About $250,000. Malcolmson, Higginbotham & Palmer, 405 Moffat Bldg., Archts.

Mich., Flint — The Bd. Educ. plans to build a 2 story, 200 x 260 ft. high school on Oak Grove Site. About $1,000,000. Steam heating system, boilers, etc., will be separate contract. Malcolmson, Higginbotham & Palmer, 405 Moffat Bldg., Detroit, Archts.

Ill., Joliet—St. Francis Academy, c/o E. P. Rother, Archt., 2507 Cullom St., Chicago, is having plans prepared for a convent including a 4 story, 88 x 200 ft. administration bldg., a 1 story domestic science bldg. and a 1 story, 40 x 128 ft. power house.

Ill., Sterling — The Northwestern Barb Wire Co. is having plans prepared for an addition to power plant. About $30,000. C. A. Chapman, 28 East Jackson Blvd., Chicago, Engr.

Ill., Waukegan—Victory Memorial Hospital, c/o Judge Edwards, is having plans prepared for a 2 story hospital including a steam heating system. About $300,000. R. E. Schmidt, 104 West Michigan Ave., Archt.

Wis., Neenah—The Valley Paper Mills, 2 Wisconsin Ave., is having plans prepared for a 1 and 2 story, 80 x 555 ft. paper mill including a separate steam power house. E. A. Wettengel, 578 Pierce Ave., Appleton, Archt.

Wis., Union Grove — The State Bd. of Control will receive bids until Aug. 16 for a 1 story power house and stack bldg. About $33,000. A. Peabody, Capitol, Madison, Archt.

Ia., Des Moines—The City c/o Water Trustees will soon award the contract for a 1 story pump station. About $150,000. Pumps, boilers, pipes and engines will be installed. Alvord & Burdick, 1418 South Dearborn St., Chicago, Ill., Archts.

Ia., Des Moines—G. Plak, c/o Central Life Assurance Co., Central Life Bldg., is having plans prepared for a 10 story, 118 x 135 ft. office building including a steam heating system on 5th and Grand Aves. About $375,000. Boyd & Moore, 1020 Grand Ave., Archts.

Kan., Kansas City — The City c/o H. Payne, plans to build a memorial building. About $500,000. Rose & Peterson, Barker Bldg., Archts.

Kan., Pittsburgh—The Pittsburgh Marble Works, Broadway, H. and P. White, Mgrs., are in the market for an electric marble scraper (Shaver) and motors.

S. D., Rapid City—The County Auditor will receive bids until Aug. 16 for a 3 story court house including a steam heating plant for the Pennington Co. About $500,000. W. E. Hulse & Co., Hutchinson, Archts.

N. D., Dickinson—The Bd. of Administration, Bismarck, Chas. Liessman, Secy., will receive bids until Aug. 9th for a power plant at Normal School here. About $40,000. Keith & Kwake, Fargo, Engrs.

Mo., Lutesville—C. Alexander plans to build an electric light plant. About $75,000. Private plans.

Mo., St. Louis—Rosati Kain Catholic Church c/o Father Casin, 4368 Lindell St., is having plans prepared for a 3 story, 80 x 178 ft. high school including a steam heating system on Newstead and Lindell Sts. About $300,000.

Tex., Kerrville—The Bldg. Bd. of Amer. Legion, Austin, will receive bids until Aug. 15 for a group of hospital buildings here. Legislature has appropriated $1,500,000. Phelps & Dewees, 718 Gunter St., San Antonio, Archts.

Tex., San Antonio—Sanguinet & Stears, Archts. First National Bank Bldg., will receive bids until Aug. 15 for an 11 story, 93 x 119 ft. bank and office building including a steam heating system for the Frost Natl. Bank, East Military Plaza. About $1,000,000.

Okla., Broken Bow—The City is having plans prepared for a waterworks system including pumping station reservoir and laying of water mains. About $120,000. Black & Veatch, Mutual Bldg., Kansas City, Engrs.

Colo., Denver — The U. S. Reclamation Service, M. Bien, Acting Director, will receive bids until Sept. 14 for furnishing two direct pumping units for the Thomas Point Pumping Plant, Lower Yellowstone Project, Montana-North Dakota.

Ont., London — H. Brazier, Engr., City Hall will receive bids until Aug. 7 for four sewarage pumps, electrically driven and controlled with 1,500 gal. per min. capacity.

Ont., London—The London District Milk Producers plans to build a co-operative dairy in East London. About $250,000. J. C. Nichols, R. R. 2. Wilton Grove, Pres. Private plans. Prices are wanted on cold storage and other equipment.

Ont., Toronto—W. W. Pearce, Bd. Educ., 155 College St., will receive bids until Aug. 4 for supplying electric motors, about 5 H.P. for the Kent and Brown Sts. schools.

Ont., Trout Mills—G. Hughes plant to rebuild shingle mill which was destroyed by fire and will be in the market for equipment including steam boiler and engine. About $4,000.

CONTRACTS AWARDED

Conn., Ansonia—The Ansonia O. & C. Co., 153 Main St., has awarded the contract for a 2 story, 75 x 125 ft. factory to Aberlhaw Constr. Co., 27 School St., Boston, Mass. About $250,000.

Conn., New Haven—The United Illuminating Co., 84 Temple St., has awarded the contract for a 2 story, 60 x 65 ft. addition to power plant on Grand St. to Standard Constr. Co., 153 Court St.

N. Y., New York—Clason Point Military Academy has awarded the contract for a 2 story, 50 x 190 ft. school on Clason Point Rd. to Carucci & Wolpert, 168 Remsen St., Brooklyn. About $250,000.

N. Y., New York—P. Lorillard Co., 119 West 40th St., has awarded the contract for a 4 story factory on Ave. A. and 72nd St. to Turner Constr. Co., 244 Madison Ave. About $500,000.

Pa., Uniontown — H. W. Altman has awarded the contract for a 2 story, 30 x 50 ft. boiler house and laundry to Colingen Bros. About $35,000.

Miss., Jackson—The Bd. of Improvement Comn. of Mississippi has awarded the contract for

Two hand fired stokers for 250 hp. water tube boilers, one to the Armstrong Mfg. Co., 615 West Liberty St., Springfield, Ohio, at $15 per sq.ft. and one to McClave-Brooks Co., Poplar and Park Sts., Scranton, Pa., at $12 per sq.ft.

Two 125 K.V.A. 3 phase, 60 cycles, 220 volt, A. C. generators to the General Electric Co., River Rd., Schenectady, N. Y., $4,300.

One 50 hp. 3 phase, 60 cycle, 220 volt, A. C. motor with pulley and slide rails to L. S. Vallely & Co., New Orleans, La., at $576.

One motor driven centrifugal pump with capacity of 600 gal. per min. against 150 ft. head and one with capacity of 60 gal. per min. against 30 ft. head to Dayton & Dowd Co., Quincy, Ill., $815 and $254, respectively.

One open type feed water heater with capacity of 20,000 lb. per hr. to H. S. B. W. Cochram Corp., New Orleans, La., Stack type, $1,037. One closed type hot water generator or heater with capacity of 2,000 gal. per hr. to Buckmaster-Luck-Malochee, Godchaux Blvd., New Orleans, La. Sim. No. 24 B. H. E-Z type, $635. To be installed in State Insane Asylum. Noted June 21.

O., Cleveland—The City has awarded the contract for the installation of a plumbing, heating and ventilating system at the New City Hospital building now under construction to W. G. Cornell Co., Leader-News Bldg., $469,940.

O., Cleveland — B. Lederman, 10709 Pasadena Ave., has awarded the contract for an 8 story, 60 x 255 ft. apartment hotel at 2026 East 107th St. to Bolton-Pratt Constr. Co., Columbia Bldg. Steam heating system will be installed. About $500,000. Noted March 9.

O., Cleveland—The Telling Belle Vernon Co., 3825 Cedar Ave., has awarded the contract for a 1 story, 40 x 75 ft. power plant to C. A. Carson Co., Euclid-Seventy-first St., Bldg., $50,000. Noted July 11.

O., Lakewood (Cleveland P. O.)—The City Ice & Fuel Co., Cadillac Bldg., Cleveland, has awarded the contract for a 1 story, 34 x 129 ft. ice plant at 2266 Warren Rd., here, to Younger & Farmer, 1670 Crawford Rd., Cleveland. About $40,000.

Mich., Detroit—The Fire Comm. has awarded the contract for furnishing and installing 3 motor driven centrifugal pumping units in new high pressure pumping station on Randolph St. to the Midwest Engineering Co., 19th and Martindale Aves., Indianapolis, Ind., $30,500.

Ill., Joliet—The Bd. Educ., c/o J. F. Skeel, Clk., has awarded the contract for a 3 story high school including a steam heating system to Simmons Dick Co., Bloomington. About $300,000. Noted June 7.

Wis., Green Bay—The Investment Corp., c/o L. M. Hansen Co., Archts., 113 West Walnut St., will build a 4 story, 100 x 200 ft. cold storage plant. Contract has been awarded to the architect. About $100,000.

Kan., Pittsburg—Fabler Bros. have awarded the contract for a 1 story, 92 x 94 ft. cold storage plant and warehouse to A. Messenger, $250,000.

Kan., Wichita—The Orpheum Theatre Co., c/o Mr. Gray, 702 Schenectady Bldg., has awarded the contract for a 3 story, 40 x 90 ft. and a 7 story, 50 x 140 ft. theatre and office building on 1st and Lawrence Sts., to Vaughn Constr. Co., Peter Trust Bldg., Omaha. About $700,000. Noted June 12.

S. D., Redfield—The City has awarded the contract for three centrifugal pumps each 100 gal. per min. capacity, one 500 gal. per min. capacity, one steam turbine and 3 electric motors, 1 fire pump, motor driven, to J. W. Hildred Co., 1019 Commerce Bldg., St. Paul, Minn., $7,599. Noted May 23.

Wash., Seattle—The University of Washington has awarded the contract for a 4 story, 70 x 229 ft. educational hall on University Campus to Dugan & Chrisman, Hinckley Bldg., $345,300.

Cal., San Diego—Bureau of Yards and Docks, Navy Dept., Washington, D. C., has awarded the contract for a breakdown service and transformer house to Newberry Electric Corp., 723 South Olive St., Los Angeles, $2,695.